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IMPACT OF NON-POINT POLLUTION CONTROL ON WESTERN LAKE SUPERIOR

RED CLAY PROJECT-WORK PLAN

Douglas County Soil and Water
Conservation District

Prepared for
Environmental Protection Agency

February 1976

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Impact of Non Point Pollution Control on Western Lake Superior

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16. ABSTRACT

The goal of the Red Clay Area project is to initiate and implement an action program for soil erosion and sediment control in the Lake Superior Basin which will lead into a basin-wide program. Institutional arrangements and vehicles for intergovernmental cooperation between local governmental implementing authorities on an interstate basis will be established to solve the basin-wide red clay erosion and sediment problems.

Various types of structural and non-structural treatment measures to control major sediment sources will be evaluated to determine quantity of sediment reduced per unit cost of treatment and the impact on water qualtiy. New and innovative techniques for controlling or preventing sedimentation will be demonstrated.

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IMPACT OF NON-POINT POLLUTION CONTROL ON WESTERN LAKE SUPERIOR

"Western Lake Superior Basin Erosion-Sediment Control Project"

RED CLAY PROJECT - WORK PLAN

A Cooperative Interstate Effort Between the Ashland, Bayfield, Carlton, Douglas and Iron County Soil and Water Conservation Districts.

by

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Chicago, Illinois 60604

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ABSTRACT

This document is the final report on the first or planning phase of a research and demonstration project funded by a grant from the United States Environmental Protection Agency (G005140-01) under Section 108 of Public Law 92-500 (1972 Amendments to the Water Pollution Control Act) to the Soil & Water Conservation Districts of Ashland, Bayfield, Douglas and Iron Counties in Wisconsin and Carlton County in Minnesota. The intent of this project is to evaluate various structural and non-structural methods and techniques of controlling erosion and sedimentation, which will cause an improvement of water quality in area streams and ultimately Lake Superior.

The work plan is the result of evaluations and surveys conducted in the "Red Clay" area of Wisconsin and Minnesota. The surveys for Carlton County, Minnesota and the Wisconsin Counties of Bayfield, Douglas and Iron were performed under a contract between the U.S.D.A., Soil Conservation Service and the Sponsors. The Lake Superior shoreline evaluations were the result of a subcontract between Ashland County, Wisconsin and Dr. Tuncer Edil of the Civil Engineering Department of the University of Wisconsin, Madison. The Extension Service of the University of Wisconsin and the University of Minnesota were responsible for the formulation of the Information and Education program.

The grant proposal, as submitted to the U.S.E.P.A., outlined a planning phase which called for surveys and evaluations by the Soil Conservation Service leading to the selection of specific sites within target watersheds that would be appropriate for assessment of the various recommended techniques. Concurrently, Dr. Edil was to identify sites and techniques along the Lake Superior shoreline in Ashland County for further study.

The proposal called for the development of an information and education program which would provide forums and formats for the dissemination and feedback of information, attitudes and concepts concerning all phases of the project.

In addition, the proposal indicated a need for the identification of institutional roles and responsibilities necessary to conduct not only the implementation phase but for work to be accomplished beyond the life of the project.

These work elements have been accomplished and are discussed in further detail in the work plan.

It is felt that the project will generate useful information and demonstrate viable techniques that will be applicable to other areas regarding:

1. Cost-effective and environmentally compatible methods of enhancing water quality through erosion and sedimentation control.
2. Protection of our valuable water resources as well as those of land.
3. Cooperative management techniques for planning and implementation of similar projects.

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I. INTRODUCTION

The peculiar qualities of the red clay soils on the South Shore of Lake Superior have puzzled residents since the first white settlers arrived. Road building was difficult and the harvest of forest products was costly. Those who tilled the soil found the red clay to be surprisingly productive but very difficult to manage. Railroad engineers found long trestles and much piling needed to span the "V" shaped valleys of the South Shore streams.

But it was in the mid 1950's that the first systematic research on land use problems of the red clay soils of Northwestern Wisconsin was begun. Early efforts were aimed at stabilizing streambanks, and reducing roadside erosion to cut down on the sedimentation in lakes and streams. Techniques such as mulching, vegetative covers, and erosion control structures were demonstrated.

State and Federal agencies with the help of local civic groups and private industry teamed up to study the problem. An Interagency Red Clay Committee consisting of the Soil Conservation Service, the Wisconsin Department of Natural Resources, the University of Wisconsin College of Agriculture, and the Wisconsin Department of Transportation was organized to carry out the research.

While sedimentation of the streams and lakes has long been of concern, it was not until about 1970 that the suspended clay was considered a pollutant. The first Lake Superior Water Quality Conference, called to focus on the taconite tailings situation on the North Shore, was the occasion at which the public was made aware of the nutrients entering the lake through erosion. When the finger was pointed at the South Shore, Governor Lucey ordered the Red Clay Interagency Committee to study the situation. The committee was charged with inventorying the extent of the sedimentation and outlining a plan of action to reduce this pollution.

At this same time the Soil and Water Conservation Districts in Douglas County Wisconsin and Carlton County Minnesota had begun to meet jointly to consider ways of reducing sedimentation from the Nemadji watershed. The City of Cloquet had secured EPA funding for a waterline in cooperation with the City of Superior. This $8.4 million project which takes water from Lake Superior experienced a water quality problem with high turbidity resulting from resuspension of clay deposits by wave action. The Soil and Water Conservation Districts with help from the Northwest Wisconsin Regional Planning Commission developed proposals for studying the problem.

Meanwhile the Soil and Water Conservation Districts responded to the report of the Red Clay Interagency Committee by accepting responsibility for developing a program to reduce red clay sedimentation. The Lake Superior Division of the Pri-Ru-Ta Resource Conservation and Development Project agreed to team up with the Carlton County Soil and Water Conservation District to develop project proposals.

During these planning efforts the Wisconsin State Board of Soil and Water Conservation Districts had been assisting local districts. In June of 1973 the State Board was instrumental in arranging a tour of the five counties by representatives from the Chicago office of the United States Environmental Protection Agency. Because this agency was already involved with water quality problems at the Head of the Lakes, they were very interested in the Red Clay Project proposals. It was with the continued encouragement of U.S.E.P.A. officials that the subsequent proposals were developed.

Table 1
Explanation of Abbreviations Used in the Text

Abbreviation		Agency, Institution or Organization
ARDC	-	Arrowhead Regional Development Commission
ASCS	-	Agricultural Stabilization and Conservation Service
CLSES	-	Center for Lake Superior Environmental Studies (University of Wisconsin-Superior)
Corps, the	-	United States Army Corps of Engineers
GLBC	-	Great Lakes Basin Commission
IJC	-	International Joint Commission
MDNR	-	Minnesota Department of Natural Resources
MPCA	-	Minnesota Pollution Control Agency
MSWCB	-	Minnesota Soil and Water Conservation Board
NACD	-	National Association of Conservation Districts
NWRP&DC	-	Northwestern Wisconsin Regional Planning and Development Commission
Project, the	-	The Minnesota/Wisconsin Western Lake Superior Basin Erosion and Sedimentation Control Project (the Red Clay Project)
RC&D	-	Resource Conservation and Development Project
RCIC	-	Red Clay Interagency Committee
RP&DC's	-	Regional Planning and Development Commissions
SCS	-	Soil Conservation Service
SWCD	-	Soil and Water Conservation District
UGLRC	-	Upper Great Lakes Regional Commission
UMD	-	University of Minnesota-Duluth
UMEX	-	University of Minnesota-Extension
USBIA	-	United States Bureau of Indian Affairs
USDA	-	United States Department of Agriculture
USDI	-	United States Department of the Interior
USDOC	-	United States Department of Commerce
USEPA	-	United States Environmental Protection Agency
USGS	-	United States Geological Survey
UWEX	-	University of Wisconsin-Extension
UW-Mad	-	University of Wisconsin-Madison
UW-Mil	-	University of Wisconsin-Milwaukee
UWS	-	University of Wisconsin-Superior
WBSWCD	-	Wisconsin Board of Soil and Water Conservation Districts
WDNR	-	Wisconsin Department of Natural Resources
WDOT	-	Wisconsin Department of Transportation

II. GENERAL DESCRIPTION OF THE "RED CLAY STUDY AREA" OF THE WESTERN ARM OF THE LAKE SUPERIOR BASIN

Geographic Setting

The five counties comprising the "Red Clay Area" (Ashland, Bayfield, Carlton, Douglas and Iron) lie in the extreme northwestern part of Wisconsin and northeastern Minnesota. The principal communities of the area are: Ashland, Bayfield, Washburn, Superior and Hurley. The City of Duluth, Minnesota and the City of Ironwood, Michigan while in proximity are outside the scope of the project. The area is served by several major highways including U.S. Highway 2 (east-west), and U.S. Highways 53, 63, 51 and I-35 (north-south).

The area lies generally about 47° north latitude and 90° to 92° west longitude. Its elevation ranges from 600 feet above sea level to approximately 1,800 feet above sea level.

The climate, which is little influenced by terrain, is classified as humid, continental with long, cold winters and short, warm summers.

The soils of the area were derived primarily from glacial clay, sand and other debris. These soils were developed under a northern hardwood-coniferous forest vegetation.

The natural vegetation, as stated above, was northern hardwood-coniferous including red and white pine, oak and birch. Subsequent to logging and agricultural use late in the nineteenth and early twentieth centuries, the land reverted to a forest with aspen as one of the dominant species. Much of the area today remains in secondary forest growth.

Geologic Setting

The area lies at the southern fringe of the Canadian Shield, a region of Precambrian sandstone and shales. The majority of these rocks lie at depth and do not affect to any extent relief or surfacial topography.

During the "Ice Age" a great deal of rock debris was transported into the area and deposited as ground, lateral and end moraine. As the glaciers melted, runoff sorted and distributed some of the morainal material forming outwash plains. During this melting period waters were trapped between the ice and topographic relief to the south forming glacial Lake Duluth, an early stage of the present Lake Superior. The red clay which includes lenses of sand was deposited in great thickness in this lake and others which extended over much of the present land area in the Lake Superior Basin.

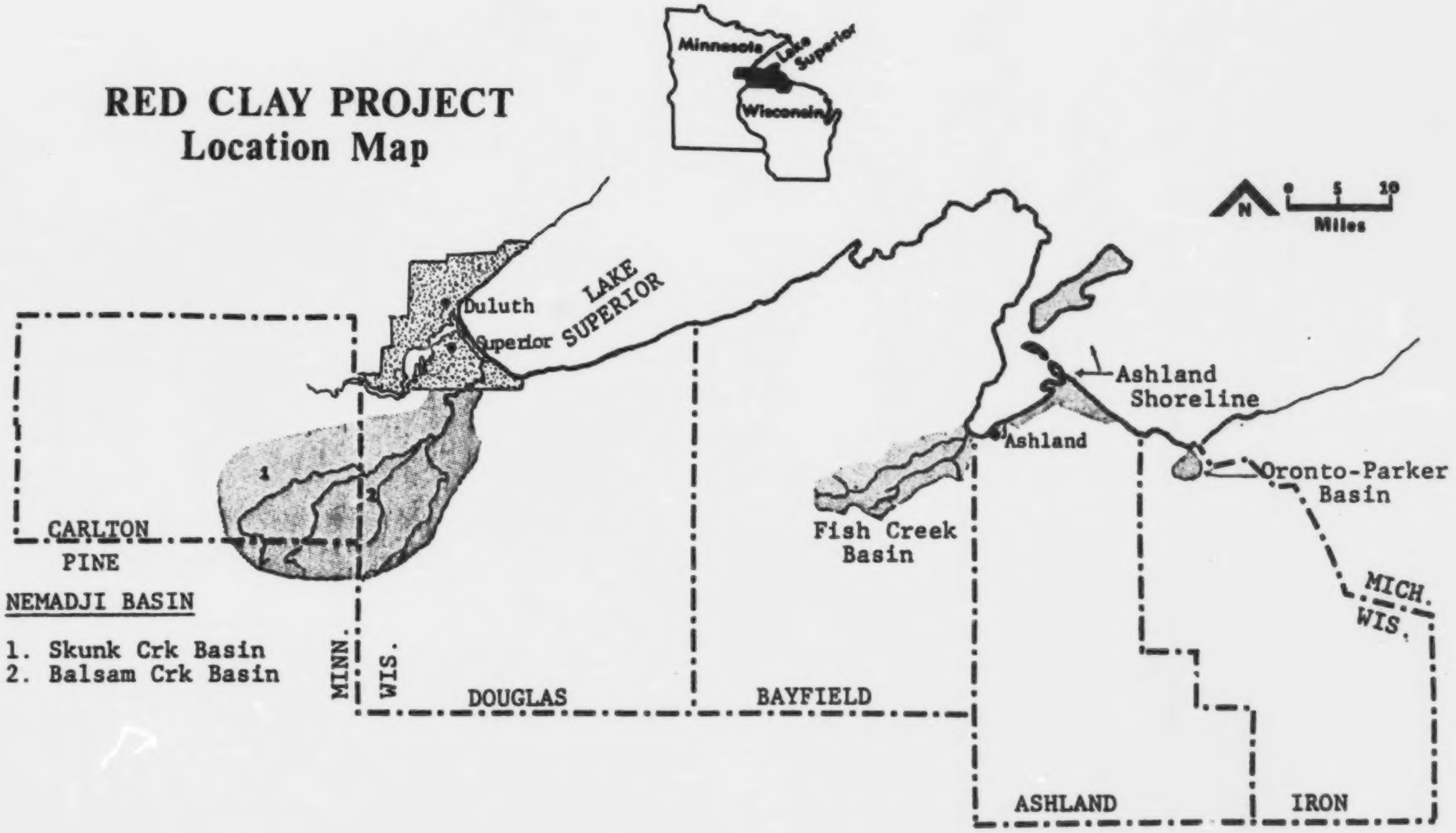
The red clays form a nearly level plain with the west and northwest being bounded by sand and gravel hills and in the south and southwest by till plain. In places beach ridges border the lake plain.

The thickness of these deposits vary from zero in bedrock outcrop area to over 600 feet.

It is the combination of all these glacial deposits that is responsible for the relief found in the area and the topography over which the modern drainage was established.

The "Red Clay Area" is geologically young and soil erosion processes still occur at a rapid rate with further acceleration due to baring of slopes by natural or man-made causes.

RED CLAY PROJECT
Location Map


Minnesota
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Wisconsin
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Miles
Duluth
Superior
LAKE SUPERIOR
Ashland Shoreline
Ashland
Oronto-Parker Basin
Fish Creek Basin
MICH.
WIS.
1
2
CARLTON
PINE
NEMADJI BASIN
1. Skunk Crk Basin
2. Balsam Crk Basin
MINN.
WIS.
DOUGLAS
BAYFIELD
ASHLAND
IRON

III. NEMADJI RIVER BASIN

Description

The Nemadji River Basin comprises 460 square miles in Carlton and Pine Counties, Minnesota and Douglas County, Wisconsin. Two hundred square miles are in Northwestern Wisconsin and two hundred and sixty square miles are in East Central Minnesota. Clayey soils make up 117,760 acres (40%) of the 294,400 acre area.

The Nemadji Basin is fan shaped with tributaries flowing roughly west to east. Land use is predominately forest land (90%) which was clear cut by the early 1900's, cropped for 25-30 years and now has a regrowth of aspen, birch and some pine. The remaining use is for crops and pasture.

Average annual precipitation for the Basin ranges between 27 and 30 inches. The mean annual temperature is about 40° Fahrenheit with monthly means ranging between approximately 8 to 12° in January and February and 64 to 66° in July and August. Temperature extremes are -43 to +105° . The frost-free period ranges between 92 and 125 days for most of the Basin. Normal snow fall is about 60 inches, and the 50 year mean recurrence of snow load is 45 pounds per square foot.

Physiographically, the Nemadji Basin is essentially a nearly level plain that represents the abandoned floor of glacial Lake Duluth which occupied the Lake Superior Basin in late Pleistocene time. Abandoned shoreline deposits form an arc mid-point in the watershed. Surface deposits include lacustrine clays and silts and gently rolling to flat ground moraine. Bedrock consists of predominantly Precambrian sandstones and shales with a section of volcanics in the southeast corner. Depth to bedrock ranges from exposed to over 600 feet.

The Basin includes the main Northeast flowing streams--the North and South Fork Nemadji Rivers which join in mid-basin. In addition the southeast flowing Blackhoof River enters the North Fork of the Nemadji mid-point in its course. The Black River watershed forms the south border. It flows oblique to and enters the main Nemadji close to the outlet into Superior Harbor Basin. Numerous auxilary streams enter the South Fork, flowing north and a few more enter the North Fork flowing southeast. The general pattern is dendritic. Topography on the lake plain ranges from a nearly flat, featureless plain to an incised, gullied ridge and valley type mid-section to a flat floodplain outlet. The lake plain is bounded on the northwest and west by rolling sand and gravel hills and on the south and southwest by a gently rolling till plain. A sandy glacial beach borders the lake plain in Wisconsin. The altitude ranges from nearly 1,270 feet mean sea level in Carlton County to 602 feet at the mouth of the river. Local relief ranges from a few tenths of a foot near the outlet to nearly 160 feet in the ridge and valley central area. The Nemadji River flows in a meandering channel that, in mid-course is entrenched some 100 to 150 feet below the surrounding nearly level lake plain. The river is generally lacking any significant terrace development.

Most of the Nemadji Watershed is underlaid by the Hinckley and Fond du Lac formations. These are of upper Precambrian age (Keweenawan) and are composed of quartzose and arkosic sandstone and interbedded shales. A portion of the watershed from the vicinity of Patzau to the south and west is underlain by middle Keweenawan volcanic formations composed mainly of basalts and andesites interbedded with sandstones, shales and conglomerates.

These in turn are overlaid by glacial till and lake laid sediments. The glacial till deposits are from the debris of the four major glaciations which invaded the area. The last glaciation, called the Wisconsin Stage, retreated from the area about 11,000 years ago. The remaining material, called drift, is composed of unsorted sand, silt and clay. The drift is believed to be from less than one hundred to over two hundred feet thick.

Upon the retreat of the glacier a large lake, Lake Duluth, was formed. Lake Duluth was 500 feet deeper and more extensive than Lake Superior - the modern offspring of Lake Duluth. Glacial Lake Duluth, because of ice blockage to the north and east, drained to the south into the St. Croix - Mississippi drainage basin during the early retreat of the glacier. The meltwaters of the glacier carried great quantities of sands, silts and clays into the Duluth basin. These materials formed some of the sand deltas, and silt and clay deposits now found. The central portion of the Nemadji Watershed is composed of the silt and reddish clay layers. Analysis of the clay indicates that the particles are mainly in the 2 micron size or smaller. The clay layers range from massive layers to very thin layers between the coarser silt. The clays in situ have very high water contents, are quite high in mica and are mainly of montmorillonite type clay. Fine grained waterlaid deposits are unconsolidated and have low shear strength.

A beach developed around the central clayey zone through wave action on the outlying glacial drift. The glacial drift is quite sandy with very little clay. The drift is classified as ground and end moraine. As the lake found its outlet to the east, the water level dropped. As it dropped, erosion cut the "V" shaped drainages into and through the clay cap.

The streams are highly meandered. The meandering has caused instability of the streambanks especially on the outside of the meanders where the stream directs most of its force.

The General Soil Map, page 16, shows the general pattern and distribution of soils in the landscape. More detailed soils information is contained in Appendix A.

A basic hydrologic model was prepared to determine peak discharges from runoff of the entire Nemadji Basin. The purpose of this basic model was to determine which tributaries contribute to the major peak discharge and sediment transport. The model takes into account the effects of topography on hydraulic flow. No attempt was made at this time to try to determine the rainfall runoff relationships that may occur at the time of sediment movement, nor the frequency of occurrences of runoff.

One stream gauge which gathers sediment data has been in operation for about 4 months in 1974. Its location near the outlet at Superior, Wisconsin, includes most of the drainage areas of the Nemadji Basin. During one small storm, sedimentation data was collected at intermittent times. With considerable projections the peak discharge from the basin was related to the sediment rates at the stream gauge. From this data it became apparent that the sediment moves with the high peak discharges. The storm rainfall, which did not exceed 2 inches with 24 hours, may be typical of the yearly or two-year storm occurrences in this watershed.

Many parts of the watershed, especially the wooded uplands, deliver almost no sediment to the stream. It appears that the majority of the sediment comes from streambank erosion.

Eighteen stream gauges in the Red Clay area of Minnesota, Wisconsin and Michigan were checked for the 10-year peak discharge from data prepared by the U.S. Geologic Survey. Only three of the gauges have sufficient data to project the 100-year flow. An analysis of this data shows the 10-year frequency to be about 150 csm (cubic feet per second per square mile) for 2 square miles (300 cfs - cubic feet per second) and 30 csm for 500 square miles (15,000 cfs). The 100-year occurrence could be projected at 350 csm for 2 square miles (700 cfs) and 60 csm for 500 square miles (30,000 cfs). This regionalized analysis does not take into account the differences in the runoff characteristics of the various tributaries. It is expected that Skunk Creek would be somewhat lower than this, that Balsam Creek would be considerably lower, and the Blackhoof and South Fork of the Nemadji Rivers would fit fairly well on this curve. The Black River probably has the lowest peak discharge of all the tributaries.

One recording rain gauge is located within the watershed at Foxboro. This one gauge when related to the surrounding gauges at Moose Lake, Duluth and Superior is not adequate coverage of the watershed for the type of storms that seem to transport considerable amounts of sediment. Additional rain gauges will be placed within the watershed to give adequate documentation of rainfall and sediment yield distribution.

Streambank Erosion Inventory

The streambank erosion survey was conducted by helicopter observations and field surveys. Field surveys were made on the two selected study subwatersheds, Little Balsam Creek and Skunk Creek. Helicopter observation was used to survey the main drainages of the Nemadji watershed. The streambank erosion and slide sites were located and recorded on 7 1/2 minute USGS topographic maps. Soils information was gathered mainly from existing soil survey data and an occasional field sample. Few deep borings have been made in the area.

The erosion study was divided into reaches that have similar physical characteristics. These reaches are shown on the Streambank Erosion Map, page 17 . .Variations in reaches include differences in floodplain width and grade, soils and character and quantity of erosion. The narrative describes the conditions found throughout the trunk streams of the Nemadji River. Investigations indicate that these conditions are representative of those existing under similar physical and geologic conditions on the tributaries. All measurements were made on 7 1/2 minute topographic maps. Both straight line distances and stream distance were measured.

The first reach is from the mouth of the river to the first Soo Line Railroad bridge. The floodplain widths range from 1,300 to 2,000 feet. The average gradient of the floodplain is about 2.5 feet per mile. The floodplain ranges from 2 to 8 feet above river level at base flow.

The soils are wet alluvial mineral soils. The soils classify from SP (clean sands) to MH (silt).[1]

The erosion in this reach consists of streambank cutting on the outside of the meanders. The cut banks are steep and raw. The erosion progresses slowly. The eroded material (mainly sand) are carried directly into the stream and become a part of the stream bedload.

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[1] Unified Soil Classification for Engineering Uses

The second reach is from the first Soo Line Railroad upstream to one mile above the Dedham - Borea bridge. The floodplain here is heavily forested and is from 1,300 to 3,500 feet wide except where Highway 35 crosses. The average grade of the floodplain is about 3.75 feet per mile. Elevation of the floodplain above the stream is about 8 feet at the lower end, rising to about 20 feet upstream from the bridge.

The soils in this reach are alluvial, mainly silt (ML-silts to low CL-clays) except for a natural levee which ranges from mainly sand to silty sand (SP-clean sand to SM-silty sand). Erosion consists of streambank undercutting, mostly in the natural levee, with accompanying slumping of the overburden soil into the stream. The streambank erosion in this reach provides additional sand to the bedload component. The slides in this reach are confined to the floodplain soils and do not extend up the valley walls.

The third reach starts from one mile above the Dedham - Borea bridge and extends to the junction of the South Fork of the Nemadji River. The valley floor narrows and the river meanders from valley wall to valley wall. The floodplain consists of short sections of bottom land between meanders, with abandoned oxbows in some of these flat sections. The floodplain gradient is about nine feet per mile. The outside of the meanders undercut the valley walls causing massive slides.

Soils in the valley floor consist of alluvial silt and clay. The valley walls are steep and soil materials are lake laid clay stratified with layers of silt and, in places, sand. The classification of clay is mainly CH whereas the silt ranges from low CL-clays to ML-silts. The floodplain and valley slopes are forested. Streambank cutting is evident on the floodplain but the main damage occurs where the stream cuts into the valley wall unstabilizing the entire slope above the cut. The valley walls reach up 150 feet in this area. The resultant massive slides are a continuing source of sediment to the stream. The sediment consists primarily of silt and clay and contributes greatly to the suspended load. Sand and gravel in the stream was probably derived from the lake bottom debris remaining from the original valley erosion process.

Reach four is located on the main trunk stream from the junction with the South Fork upstream to where the Nemadji River and Nemadji Creek join.

Reach five is on the South Fork from the junction upstream to the confluence of Clear and Anderson Creeks in section 12, T46N, R17W. The floodplain and valley slopes are forested.

These two reaches are very similar in soil, slope and erosion characteristics. The dissected floodplain is about 400 feet wide in the lower part but it disappears as the valleys narrow to ravines in the upper end. The soils are composed of lake laid sediments ranging from CH (clay) to ML (silt). In places the stream has cut into the underlying till providing an additional source of sand and gravel to armour plate the stream bottom. The till soils range from SM (silty sand) to GM (silty gravel).

Table 2 , page 13 summarizes the streambank inventory data collected for the Nemadji River.

Roadside Erosion

Roadside erosion is a major man-made source of sediment in the Nemadji Basin. Large volumes of sediments are deposited in streams from the roadside each year, resulting in increased maintenance costs and pollution of receiving waters.

Ironically, much of the roadside erosion results from roadside maintenance activities. Removal of sediments from road ditches expose bare, unstable soil slopes and concentrates runoff water. Small land slips develop and sediment deposition in the road ditches increases. Concentrated runoff water carries some of the sediment to nearby streams. Some of the sediment remains to clog the road ditch. More maintenance is required and the cycle begins again.

Detailed roadside erosion surveys were conducted to update data previously collected for the basin. State and local public roads were field checked to identify and estimate the amount of erosion taking place within road rights-of-way.

The following criteria were used to identify and record active roadside erosion:

1. Bare ground surfaces more than 100 square feet were located on a map. It is assumed that surfaces smaller than this will revegetate themselves in a short period of time.

2. The type and amount of control measures were recorded in order to determine cost of treatment.

It was determined from these field observations that three types of erosion conditions occur along the roadsides: 1) A small bare patch where sheet erosion removes small volumes of sediment. These areas constitute a moderate erosion hazard and produce low sediment volume. Seeding is needed to control erosion on these sites. 2) A large bare area with a developed pattern of rills and small gullies. These areas constitute a severe erosion hazard and produce large volumes of sediment. Shaping and seeding are needed to control erosion on these sites. 3) A large bare area with large gullies, land slips and slides within the area. These areas constitute a very severe erosion hazard and produce large volumes of sediment. Grade stabilization structures, shaping and seeding are needed to control erosion on these sites.

TABLE 2

STREAMBANK EROSION INVENTORY - NEMADJI RIVER

Reach	Channel Description			Erosion Description		
No.	Straight Line Length (Mi)	Channel Length (Mi)	Channel Gradient (Ft/Mi)	Channel Erosion No/Mi[1]	Slides No/Mi[1]	Magnitude of Erosion
1	4	6.7	0.6	1.1	-	Moderate
2	9.5	16.4	1.8	4.5	-	Moderate
3	5	8.8	6.4	3.2	2.2	Severe
4	11.5	20.5	10.4	1.2	2.1	Very Severe
5	8	13.0	10.8	1.9	3.2	Very Severe

[1] Average number of sites per mile of channel length

The following table provides a breakdown of the roadside erosion control needs and estimated costs.

TABLE 3
WISCONSIN NEMADJI BASIN ROADSIDE EROSION NEEDS AND COSTS

County	Critical Area Seeding[1]	Area To Shape[2]	Earth Moving[3]	Structures[4]	Instal. Costs	Tech. Assist.[5]	Total Cost
Douglas							
TWP RDS	15.3 Ac.	9.5 Ac.	4,040 cu. yds	5	36,400	7,085	43,485
CO. RDS	4.3 Ac.	4.2 Ac.	480 cu. yds	2	10,530	2,100	12,630
STATE RDS	1.6 Ac.	1.4 Ac.	2,225 cu. yds	2	12,455	2,290	14,745
CITY RDS	5.4 Ac.	5.2 Ac.	8,425 cu. yds	6	43,615	8,525	52,140
Total for CO.	26.6 Ac.	20.3 Ac.	15,170 cu. yds	15	103,000	20,000	123,000

1 Includes all areas that require critical area seeding

2 Includes areas that require either mechanical or hand shaping before seeding

3 Cubic yards of fill required before shaping & seeding

4 Locations where a mechanical spillway is required

5 20% installation costs

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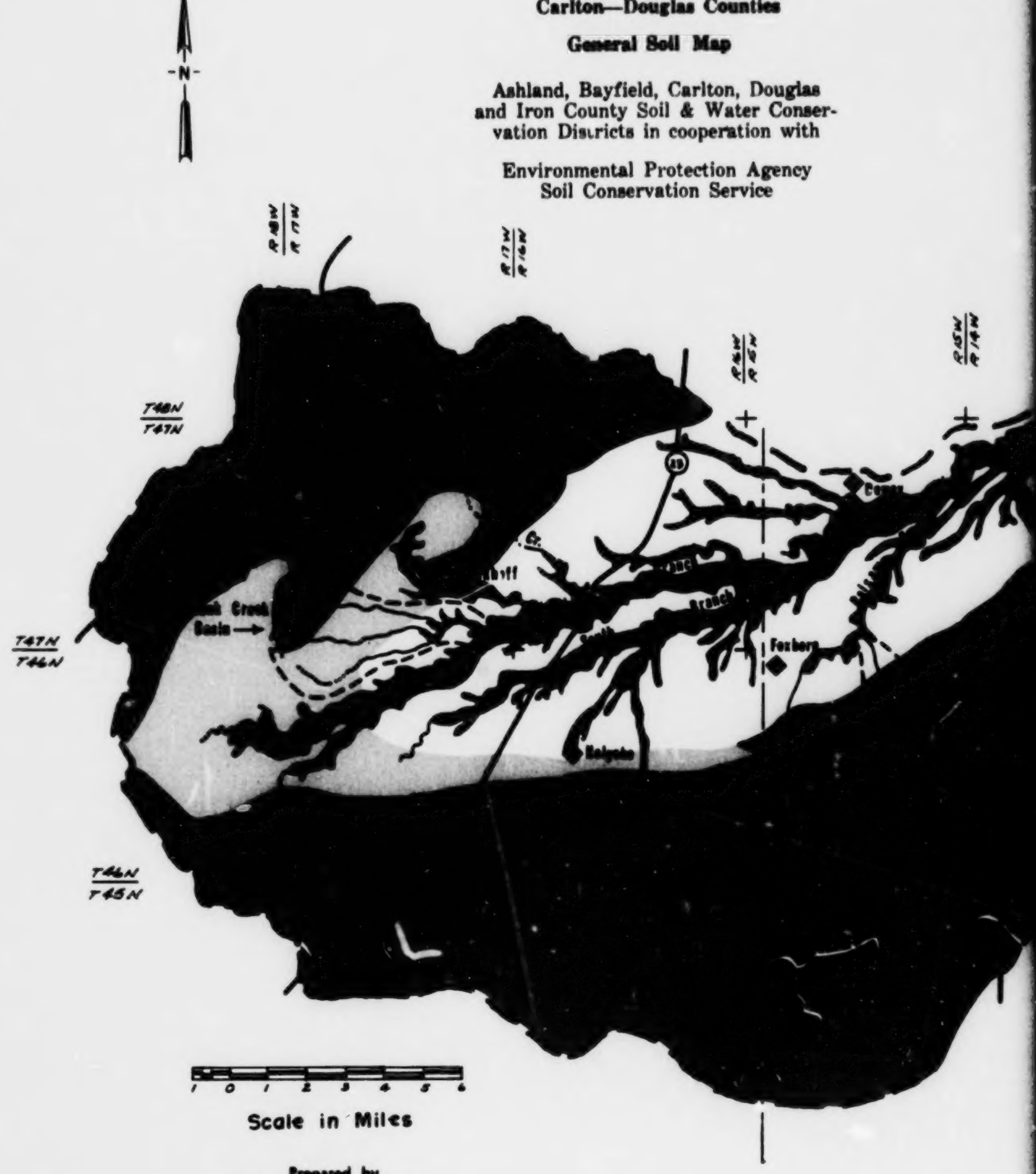
WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Nemadji River Basin
Carlton—Douglas Counties

General Soil Map

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conser-
vation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service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R17W
R17W
R16W
R16W
R15W
R15W
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T48N
T47N
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T45N
35
Cr.
Creek Basin
Branch
Foxboro
1 0 1 2 3 4 5 6
Scale in Miles

Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975

AKE SUPERIOR BASIN
consin-Minnesota

adji River Basin
—Douglas Counties

eral Soil Map

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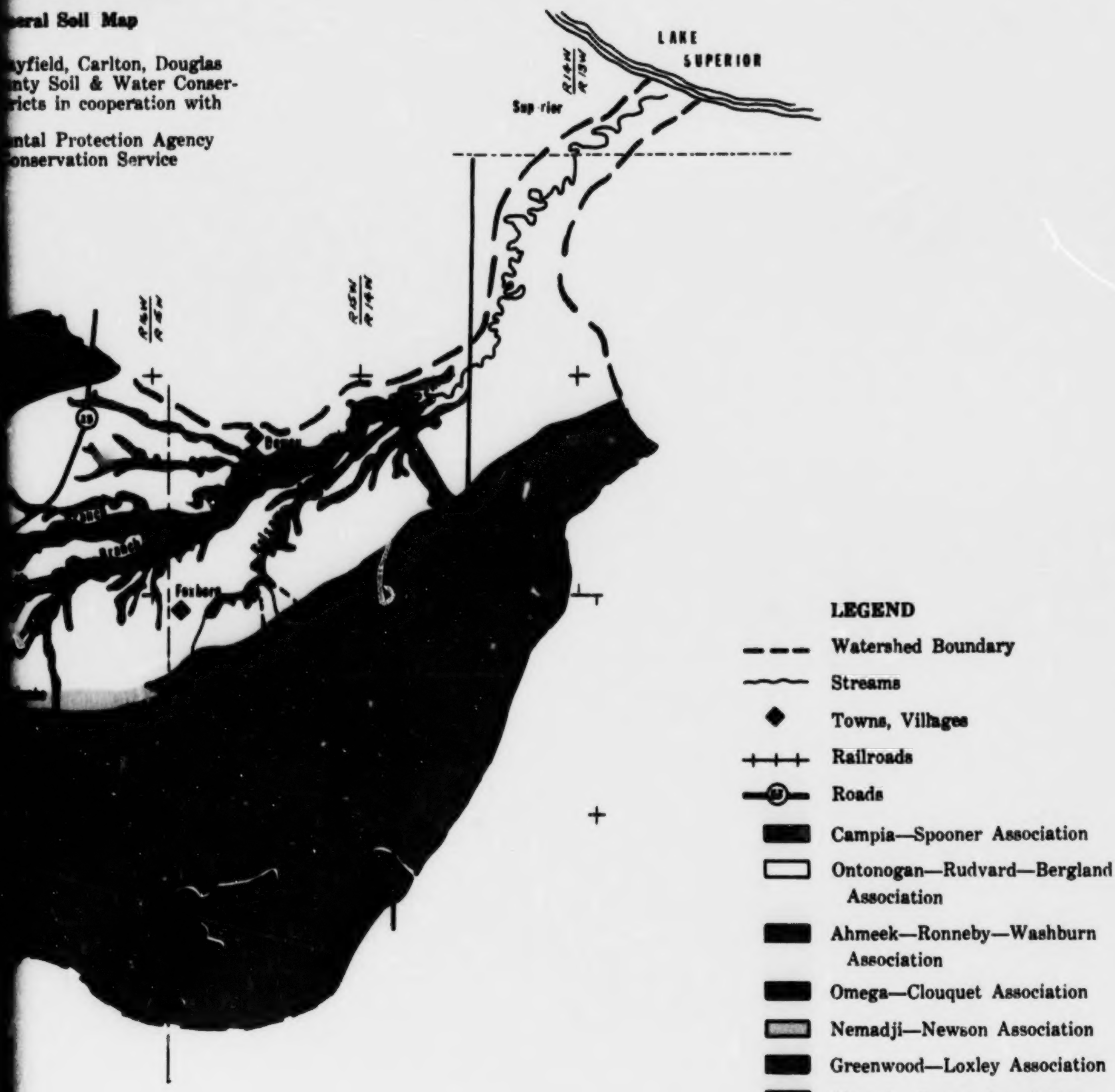
LAKE SUPERIOR
Superior
R14W
R13W
R16W
R15W
R15W
R14W
35
Branch
Foxboro
LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads
Campia—Spooner Association
Ontonogan—Rudvard—Bergland Association
Ahmeek—Ronneby—Washburn Association
Omega—Clouquet Association
Nemadji—Newson Association
Greenwood—Loxley Association
Ahmeek—Omega Association
Steep clayey land

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Nemadji River Basin
Carlton—Douglas Counties

Streambank Erosion

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conser-
vation Districts in cooperation with

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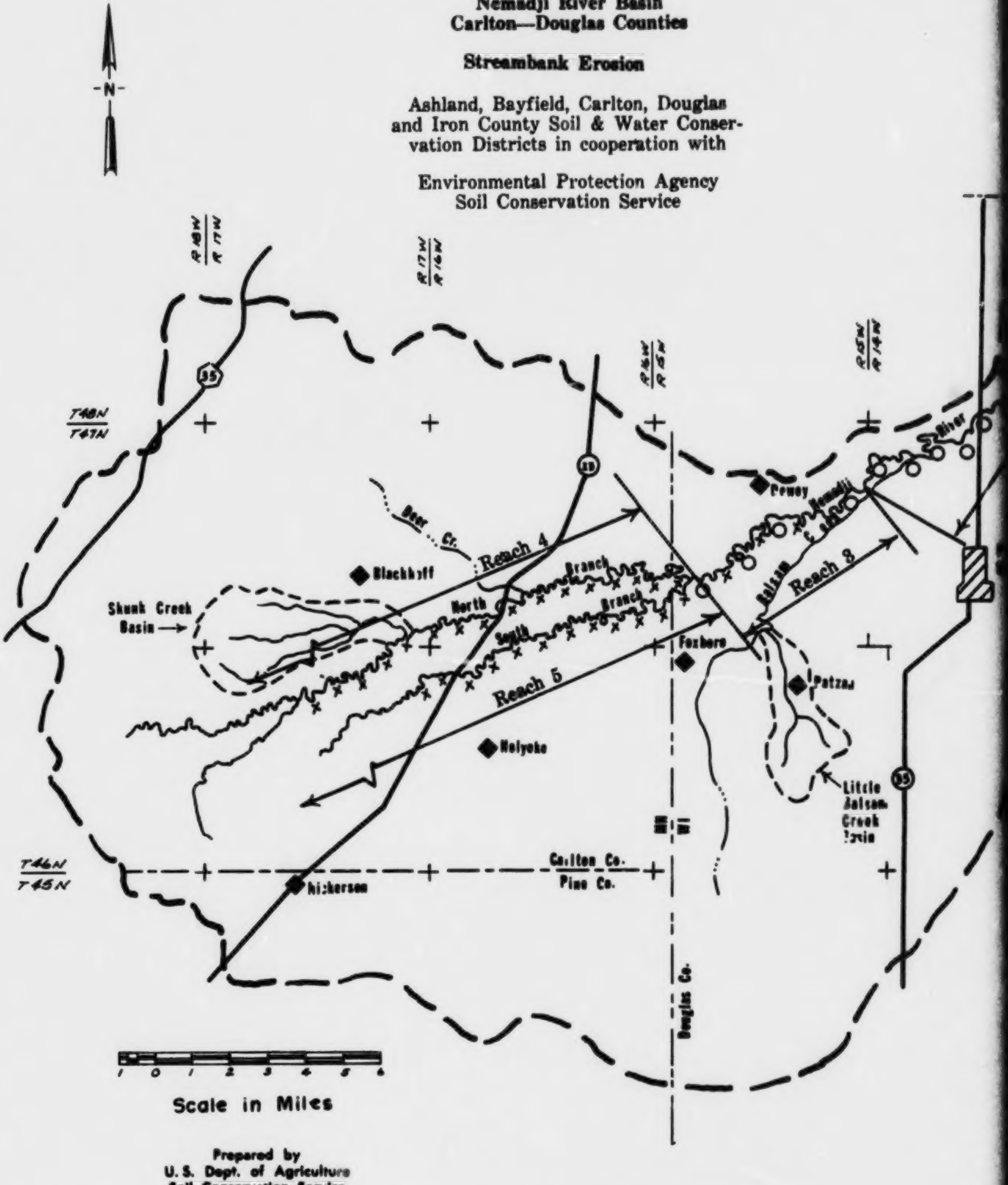
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35
23
Deer Cr.
Reach 4
Reach 5
Reach 8
Blackhoff
Shunk Creek Basin
North Branch
South Branch
Holyoke
Foxboro
Dewey
Nemadji River
Balsam
Patzau
Little Balsam Creek Basin
Carlton Co.
Pine Co.
Douglas Co.
MINN
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Nickerson
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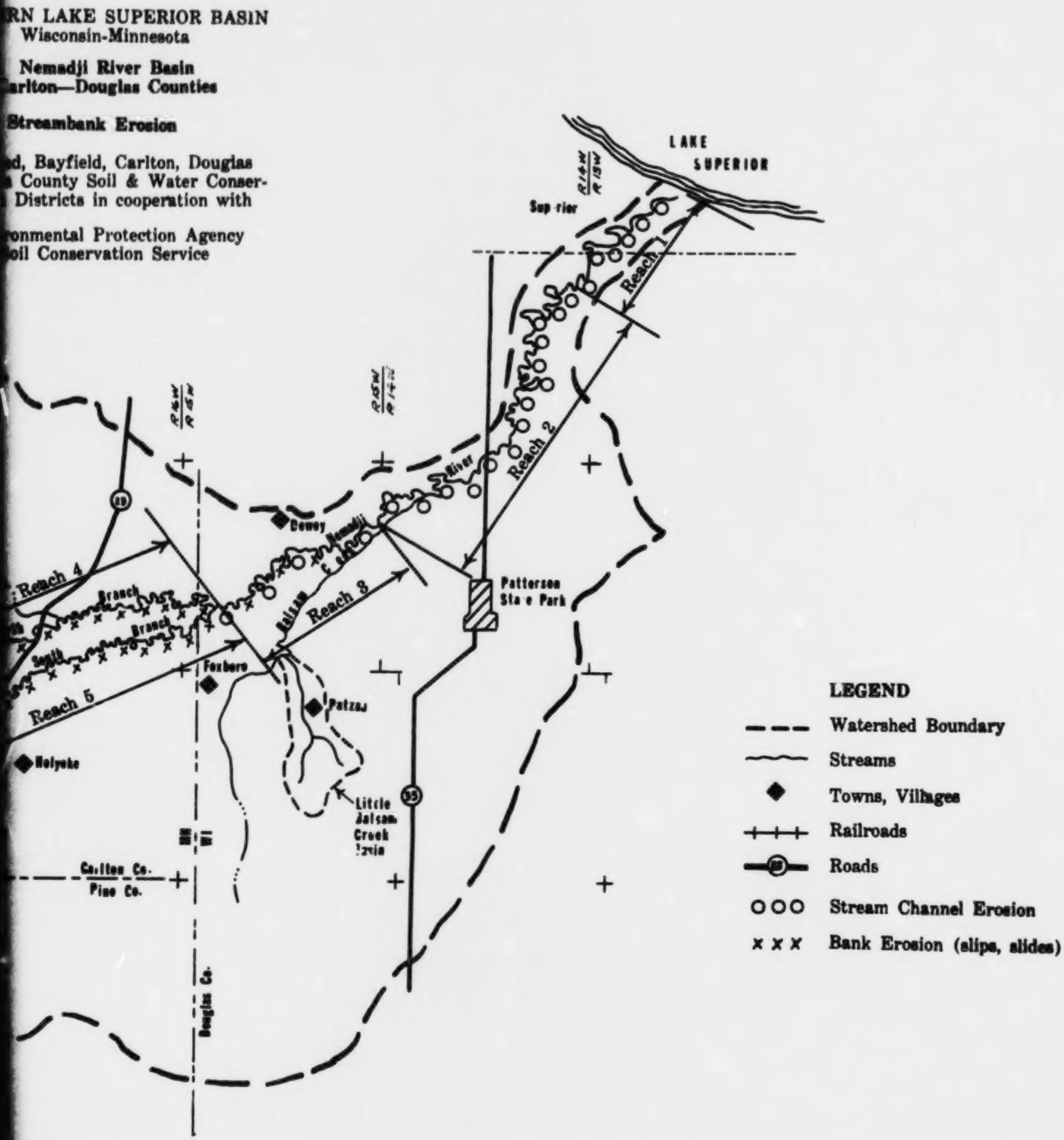
Scale in Miles

Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975


RN LAKE SUPERIOR BASIN
Wisconsin-Minnesota
Nemadji River Basin
arlton—Douglas Counties
Streambank Erosion
d, Bayfield, Carlton, Douglas
County Soil & Water Conser-
Districts in cooperation with
onmental Protection Agency
oil Conservation Service
LAKE SUPERIOR
Superior
R14W R15W
R15W R14W
R16W R15W
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Nemadji River
Branch
South Branch
Balsam
Dewey
Foxboro
Patzau
Holyoke
Patterson State Park
Little Balsam Creek Basin
35
Carlton Co.
Pine Co.
Douglas Co.
LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads
Stream Channel Erosion
Bank Erosion (slips, slides)

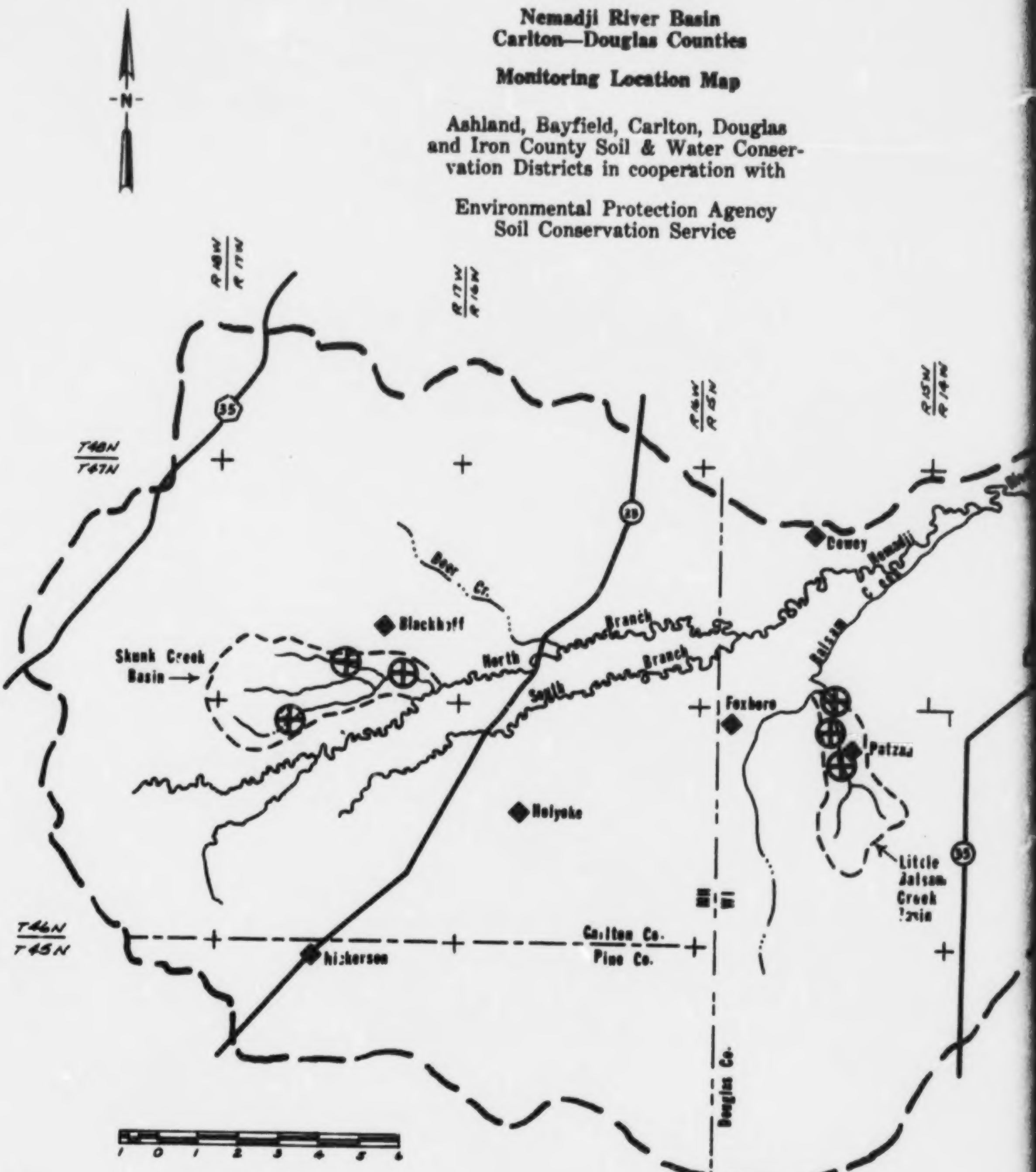
WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Nemadji River Basin
Carlton—Douglas Counties

Monitoring Location Map

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conser-
vation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service



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R17W / R16W
R16W / R15W
R15W / R14W
T48N / T47N
T47N / T46N
T46N / T45N
35
23
Beer Cr.
Blackhoff
Skunk Creek Basin
North Branch
South Branch
Cowey
Nemadji
Balsam Cr.
Foxboro
Patzau
Little Balsam Creek Basin
Holyoke
Carlton Co. / Pine Co.
Nickerson
MN
WI
Douglas Co.
35
1 0 1 2 3 4 5 6

Scale in Miles

Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975

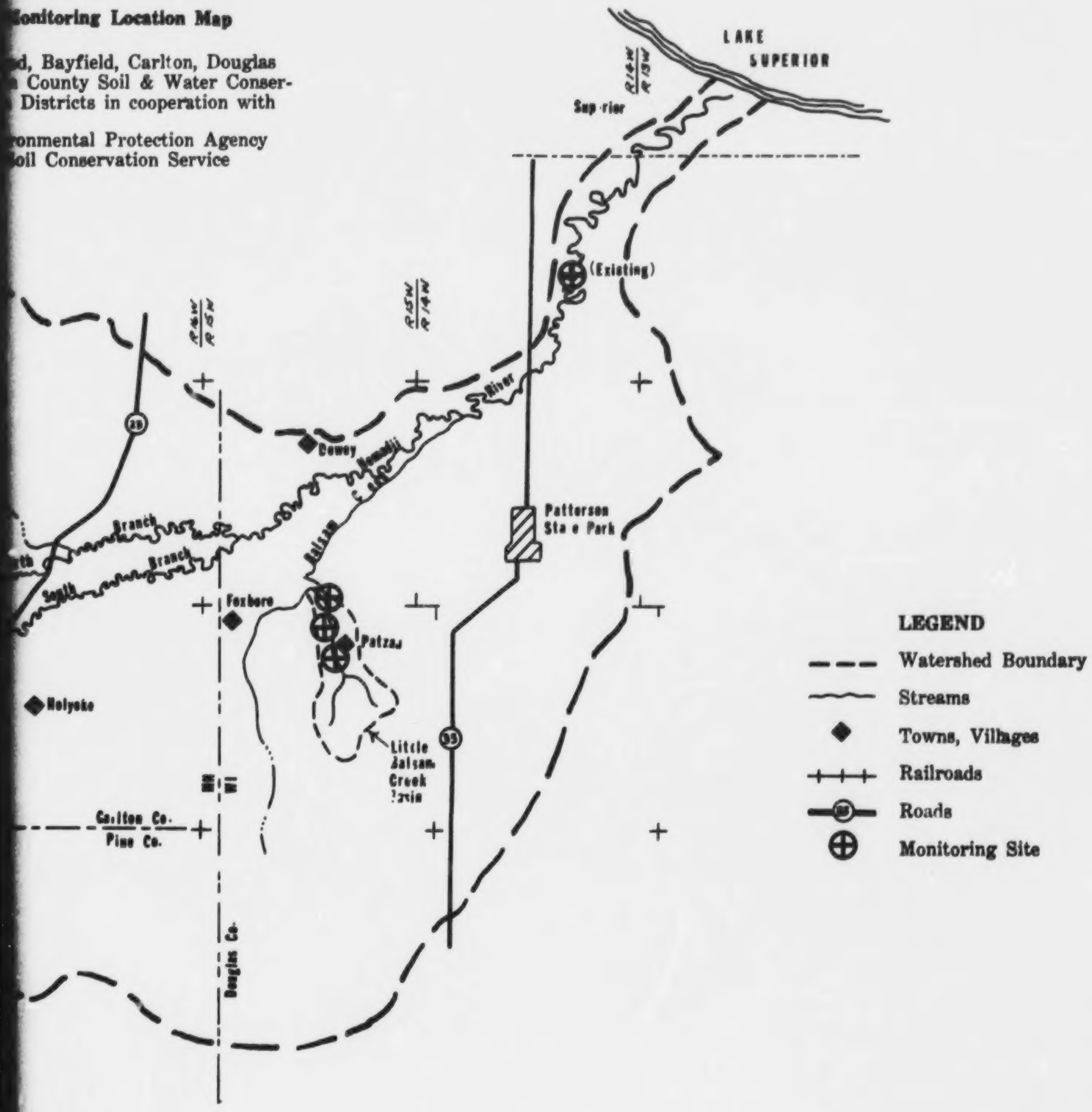
RN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Nemadji River Basin
Carlton—Douglas Counties

Monitoring Location Map

d, Bayfield, Carlton, Douglas
County Soil & Water Conser-
Districts in cooperation with

ronmental Protection Agency
Soil Conservation Service


LAKE
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River
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Dewey
Branch
Branch
North
South
Balsam
Foxboro
Patzau
Patterson
Sta e Park
Holyoke
Little
Balsam
Creek
Basin
MN
WI
Carlton Co.
Pine Co.
Douglas Co.
35
35
LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads
Monitoring Site

SELECTION OF SUBWATERSHED STUDY AREAS

Study areas representative of conditions in the entire watershed were selected using the following criteria:

1. The proportion of loamy glacial till and sandy beach deposits in the uplands with respect to the clayey lacustrine basin.
2. The relationship of present land use patterns within the subwatersheds to land use patterns in the entire Nemadji Basin. The ratio of open cropland and/or pasture to woodland indicates the relative intensity of land use within the area.
3. The presence of active eroding slips and slides along the river channels and drainageways. Slide and erosion conditions representative of those in the Nemadji Basin.
4. The roadside erosion taking place within the subwatershed areas. Roadside erosion that would be representative of the entire Nemadji River Basin.
5. The land ownership pattern. We were interested in private land versus public land. Land rights are generally easier to obtain on publicly owned land and future maintenance and operations agreements would be easier to manage.
6. Access to the work sites. Most of the eroding areas have ver limited access. It will be necessary to do some access road construction. This will be held to a minimum by working in the selected study areas.
7. The relative amount of sediment produced in the subwatersheds. One study area that produced a relatively large amount of sediment and one that produced a moderate amount of sediment were selected. This selection will show the effectiveness of corrective measures on sediment reduction in both the high and moderate sediment producing study areas.

Using these considerations the following subwatershed study areas were selected as being representative of the entire watershed:

Skunk Creek Basin in Minnesota - A relatively high sediment-producing basin covering approximately 10.7 square miles. The land use intensity within the basin is relatively low. However, there are numerous slips and slides in this subwatershed.

Little Balsam Creek in Wisconsin - A moderate sediment-producing watershed covering approximately 5.4 square miles. Land use within the watershed is a relatively low intensity.

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TABLE 4
CRITERIA USED TO SELECT SUBWATERSHED STUDY AREAS

	Watershed Name					
Criteria	Nemadji	Little Balsam Wis.	Skunk-Duesler Minn.	Unnamed Wis.	Rocky Run Wis.	Stoney Brook Wis.
Approx. Area Drained in Sq. Miles	460	5.4	10.7	3.0	3.0	2.5
Percent of Total Watershed	100	1.2	2.3	0.6	0.5	0.5
Soils (% of Watershed Area)						
Lake Plain	32	30	30	80	80	90
Beach	18	15	35	20	20	10
Upland	56	55	35	0	0	0
Straightline Miles of Stream	35	4.5	7.0	3.0	3.5	4.0
Land Use						
% Openland	10	11	25	35	75	70
% Forestland	89	88	75	65	25	30
% Urban	1	1				
Ownership						
% Private	45	45	85	100	90	95
% Public	55	55	15	0	10	5
Accessability	Moderate	Good	Moderate	Good	Good	Good

TABLE 4 (cont.)

Criteria	Watershed Name Rock Creek Wis.	Sec. 36 Creek Minn.	Stoney Brook Minn.	Rock Creek Minn.	Deer Creek Minn.
Approx. Area Drained in Sq. Miles	5.0	6.0	6.0	8.0	8.5
Percent of Total Watershed	1.1	1.3	1.3	1.7	1.8
Soils (% of Watershed Area)					
Lake Plain	45	75	45	60	40
Beach	20	10	20	15	25
Upland	35	15	35	25	35
Straightline Miles of Stream	7.6	6.0	2.5	7.0	7.5
Land Use					
% Openland	45	15	2	0	15
% Forestland	55	85	98	100	85
% Urban					
Ownership					
% Private	95	50	100	80	80
% Public	5	50	0	20	20
Accessability	Poor	Poor	Good	Moderate	Poor

SKUNK CREEK WATERSHED STUDY AREA

Description

The Skunk Creek Watershed comprises a drainage area of approximately 10.7 square miles (6,870 acres) in southeastern Carlton County, Minnesota. The watershed lies 7 miles east of Barnum, Minnesota. It is about 6 miles long and about 3.5 miles wide at the widest point. Skunk Creek, the main stream, drains the southern and western part of the watershed. It is joined by Duesler Creek in the central part and Elim Creek in the north part. The Soo Line Railroad bisects the watershed in a northeast-southwest direction. Three small tributaries join the stream near its outlet below County Highway 103.

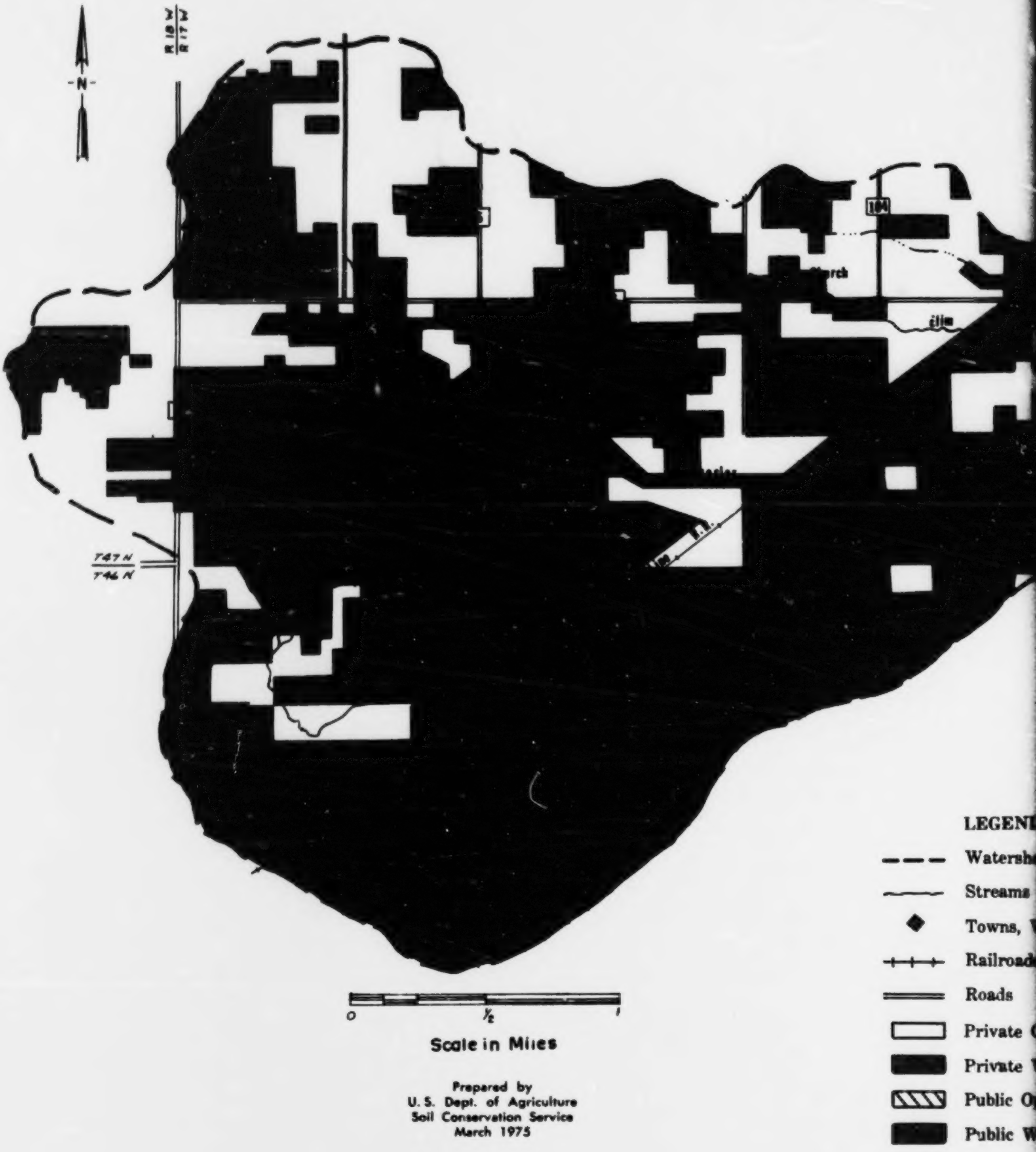
The basin is rural with no population centers. There are no major industrial or recreational sites. About 73% is forest land, 16% is cropland, 7% is pasture and 4% is other land such as roads and other miscellaneous uses. The map on page 23 illustrates land use and ownership in the Skunk Creek Basin.

The basin originally supported a coniferous forest consisting of mainly white pine, red pine and jack pine. This was logged off around the turn of the century and the land periodically burned. Most of the original stands were succeeded by aspen and paper birch. Aspen is the most abundant species today. Red pine is the primary species planted for saw log production. Other species present are balsam fir, white spruce and jack pine. On the wetlands black spruce, tamarack, black ash and northern white cedar are the dominate species. The forest industry is an important segment of the basin's economy.

The elevation of the watershed ranges from about 805 feet at the east end to 1,090 feet above sea level at the extreme west end. It is mostly within the lake laid sediments of Glacial Lake Duluth. Surface deposits in the eastern part consist mainly of clay with some silt and fine sand layers. It is into these erosive sediments that Skunk Creek and its tributaries are entrenched, up to more than 100 feet at the lower end. Gently undulating sandy deposits that are wet in depressions are located in the central part. A small island of loamy glacial drift is in the west central part. The northwest part is a gently sloping to rolling sandy and gravelly outwash plain.

The underlying rock is the Hinkley and Fond du Lac (Keweenawan) formations of Precambrian age. They are composed of mainly quartzose and arkosic sandstones and interbedded shales. These are too deep to influence proposed works of improvement.

Overlying the bedrock is the debris from the four major glaciations that covered the area. This deposit called drift is, in places, quite dense and slowly permeable. It is composed of sand, silt and clay with pockets and lenses of clean sand, in places water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Railroads
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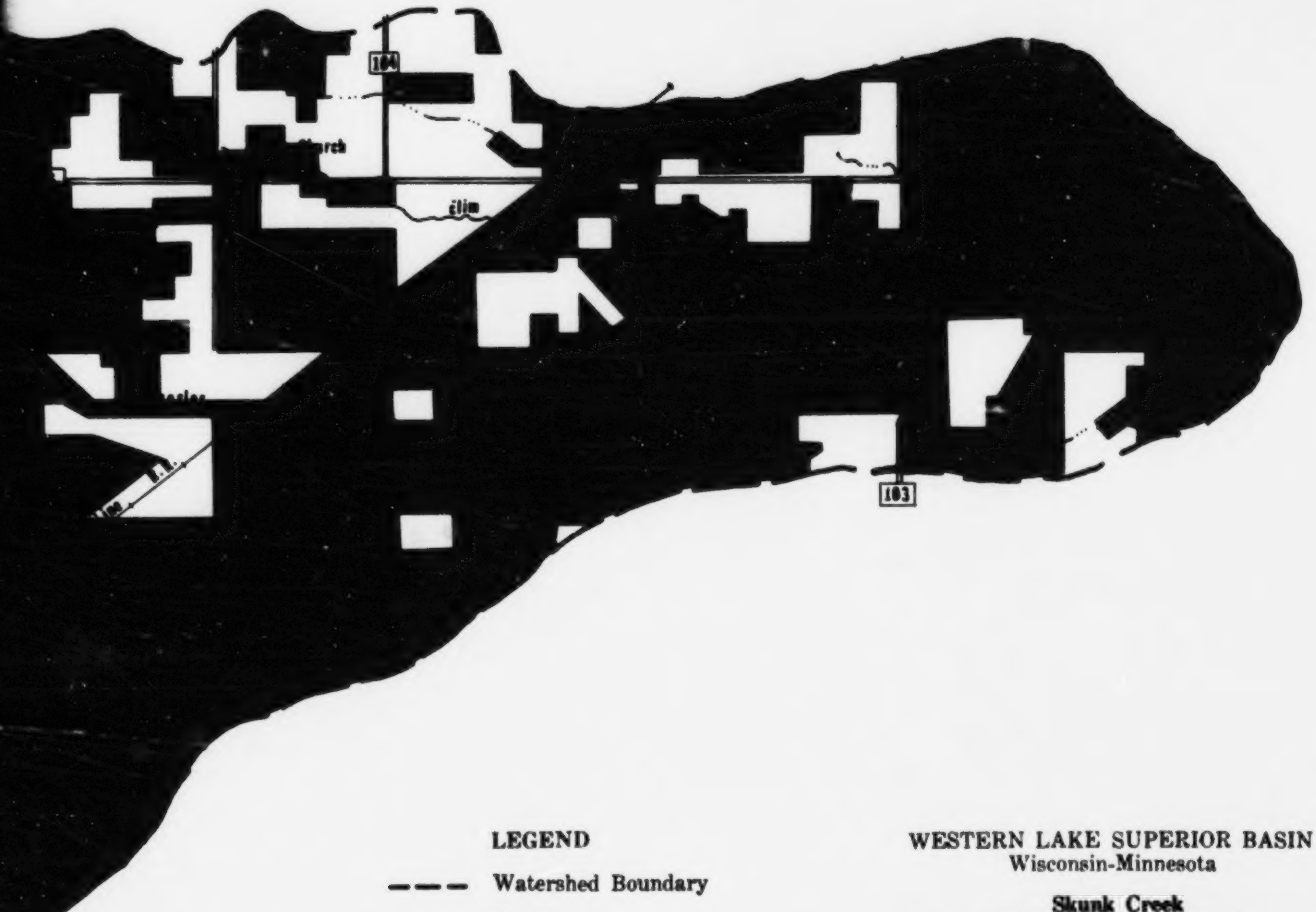
Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975



LEGEND

— — — Watershed Boundary

∼ Streams

◆ Towns, Villages

┼┼┼ Railroads

═ Roads

☐ Private Open Land

■ Private Woodland

▨ Public Open Land

■ Public Woodland

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Skunk Creek
Carlton County, Minnesota

Land Ownership Map

Ashland, Bayfield, Carlton, Douglas and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

bearing. This drift is exposed in the west central part of the basin. A strip through the middle of the basin has been modified by wave action to form a sandy beach deposit.

Land Capability

The land capability units represent groupings of soil with common limitations for agricultural and woodland uses. The soils in each unit show similar responses to like treatment under similar use patterns.

The capability groupings presented here are intended for use in this report only.

There are 25 different kinds of soil in the Skunk Creek, Minnesota study area. These soils make up a total of 18 land capability units which are used in determining land treatment needs. A more detailed description of the soils in each capability unit, their characteristics and limitations are contained in Appendix A. The major soils within each land capability unit are listed in Table 5. The land capability unit distribution pattern is shown on page 25.

Table 5
Soils Data by Land Capability Unit

	Acreage	Major Soil Series	Major Hazard	Slopes (%)
IIe1	142	Baudette, Duluth	Erosion	0-2
IIw2	50	Spooner	Wetness	0-2
IIIe2	105	Superior	Erosion	3-11
IIIs[1]	1,669	Ontonagon	Ponded Water	0-2
IIIw2	42	Dusler	Wetness	0-2
IIIw3	130	Allendale	Wetness	0-2
IVe[2]	204	Baudette, Duluth	Erosion	3-11
IVe[3]	166	Ontonagon	Erosion	3-11
IVs1	1,324	Omega	Drouthiness	0-11
IVw2	897	Newson	Wetness	0-2
IVw3	787	Nemadji	Wetness	0-2
IVw4	125	Mahtowa, Blackhoof	Wetness	0-2
IVw[4]	327	Rudyard, Bergland	Wetness	0-2
IVw[5]	33	Beseman, Dawson	Wetness	0-2
IVw[5]	21	Bain	Wetness	0-2
VIIe1[6]	378	Ontonagon	Erosion	12-24
VIIs1	50	Omega	Drouthiness	12-24
VIIIe[7]	420	Steep Clayey Land	Erosion	25-45

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[1] Class IIs1 in Appendix B

[2] Class IIIe1 in Appendix B

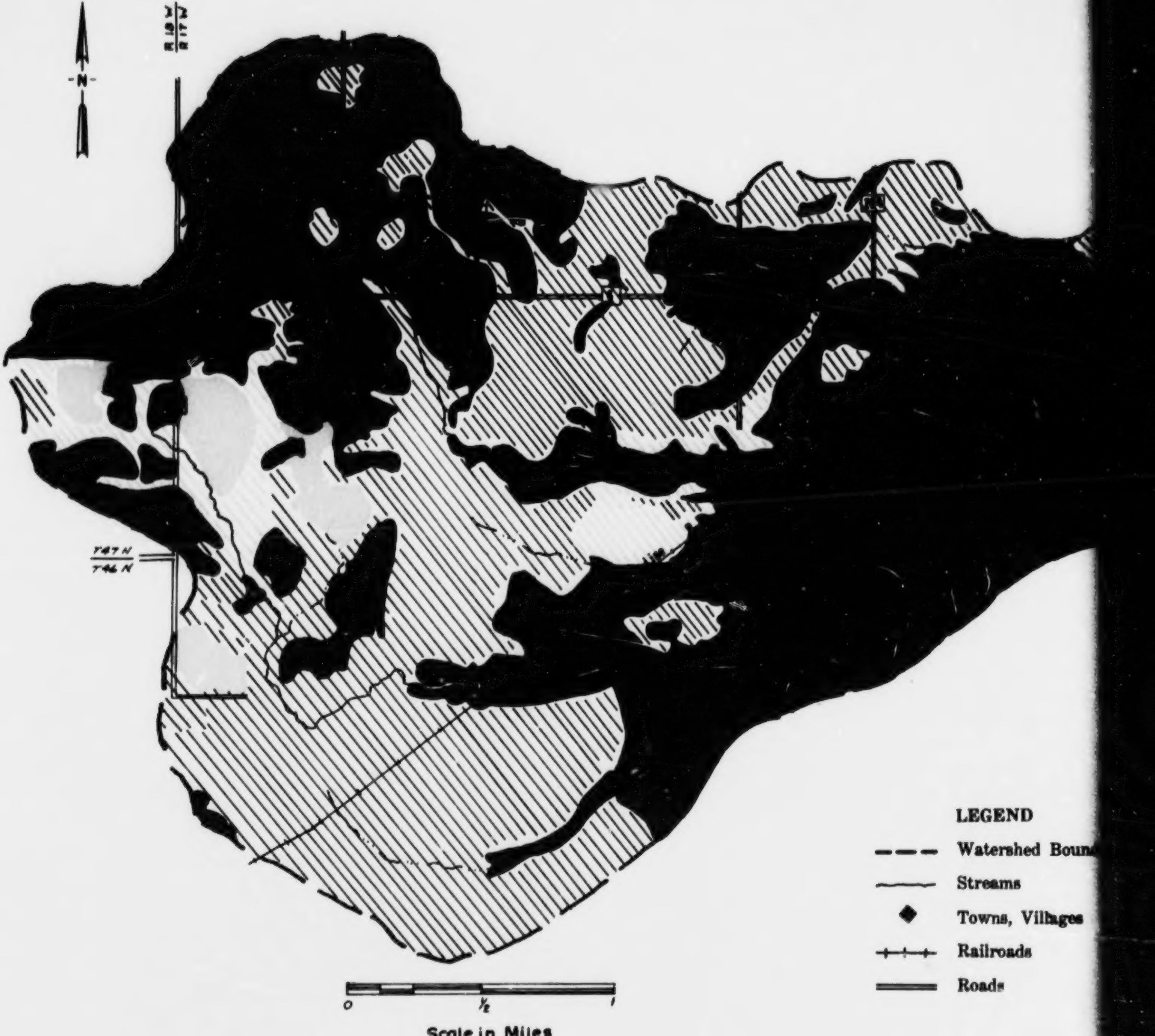
[3] Class IIIe2 in Appendix B

[4] Class IIIw1 in Appendix B

[5] Class VIIw1 in Appendix B

[6] Class IVe2 in Appendix B

[7] Class VIIe1 in Appendix B


N
R18W
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T47N
T46N
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Watershed Boun
Streams
Towns, Villages
Railroads
Roads
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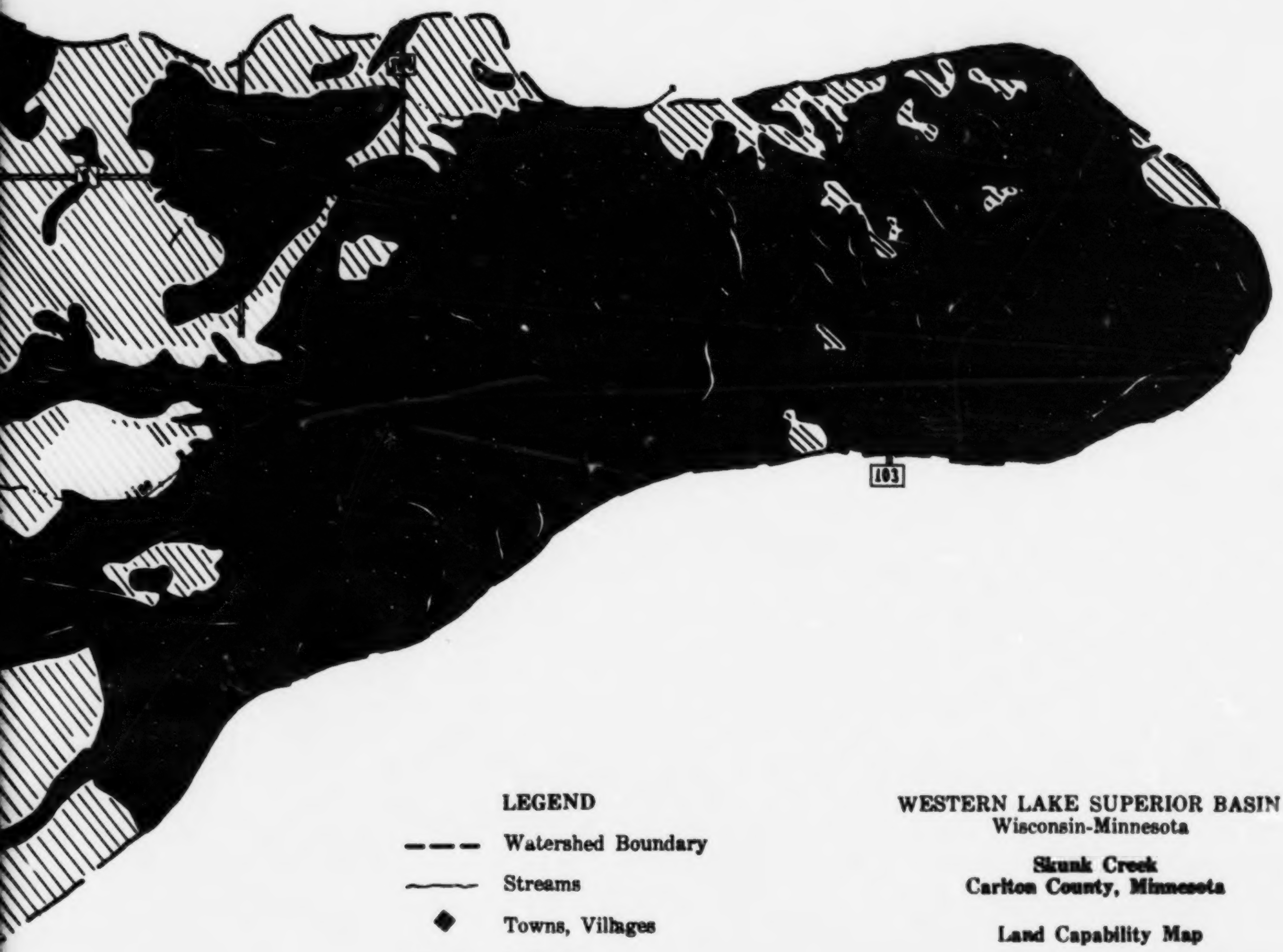
Scale in Miles

Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975


Capability Classes
▨ Class IIe and IIs
☐ Class IIw
■ Class IIIe
▧ Class IIIw
■ Class IVe and IVs
▧ Class IVw
■ Class VIIe and VIIs
■ Class VIII
103
LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Skunk Creek
Carlton County, Minnesota

Land Capability Map

Ashland, Bayfield, Carlton, Douglas and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

Streambank Erosion

Streambank erosion data in the Skunk Creek study area was collected by field survey. For the purpose of this study, erosion sites were identified by: 1) fresh exposure of soil or alluvium, 2) scarcity or absence of vegetation, 3) recent evidence of slumping or movement, and 4) other visible signs of recent erosion. Table 6 and the accompanying map, page 28, is a summary of the streambank erosion inventory.

Land Treatment Needs

An analysis of the study area was made to identify the types and amount of land treatment needed to reduce soil erosion.

This study was completed by Soil Conservation Service personnel based on established procedures.

Table 7 lists the various practices and cost schedule which should be applied in the study area to achieve adequate land treatment and erosion control. It should be pointed out that the success of this program will depend on planning with individual landowners and Sponsors. It is anticipated that treatment of the area will allow an accurate assessment of the effect of the program on water quality.

Table 8 is the schedule for achieving this treatment over a three-year period. The work location map is on page 32. The practices listed are briefly described in Appendix C. The amounts listed are in addition to practices currently applied in the study area.

The S.C.S. will assist the Soil and Water Conservation Districts in signing up landowners as district cooperators within the study area. This will indicate the extent of local cooperation to be expected and will provide an opportunity to further explain the sediment reduction program. It also provides the means by which the S.C.S. is authorized to provide technical assistance to local landowners within the study area.

A conservation plan will be developed with each cooperator with the assistance of the S.C.S. The conservation plan is a record of the land treatment measures the landowner agrees to apply, the amount of each measure and the projected date of installation. This plan will also serve as the basis for financial cost sharing on the installation of erosion control measures. Installation of selected measures will be carried out by the cooperator with technical assistance from the S.C.S. staff and cost sharing assistance from the S.W.C.D. Landowners that require forestry techncial services will be assisted by the Minnesota Department

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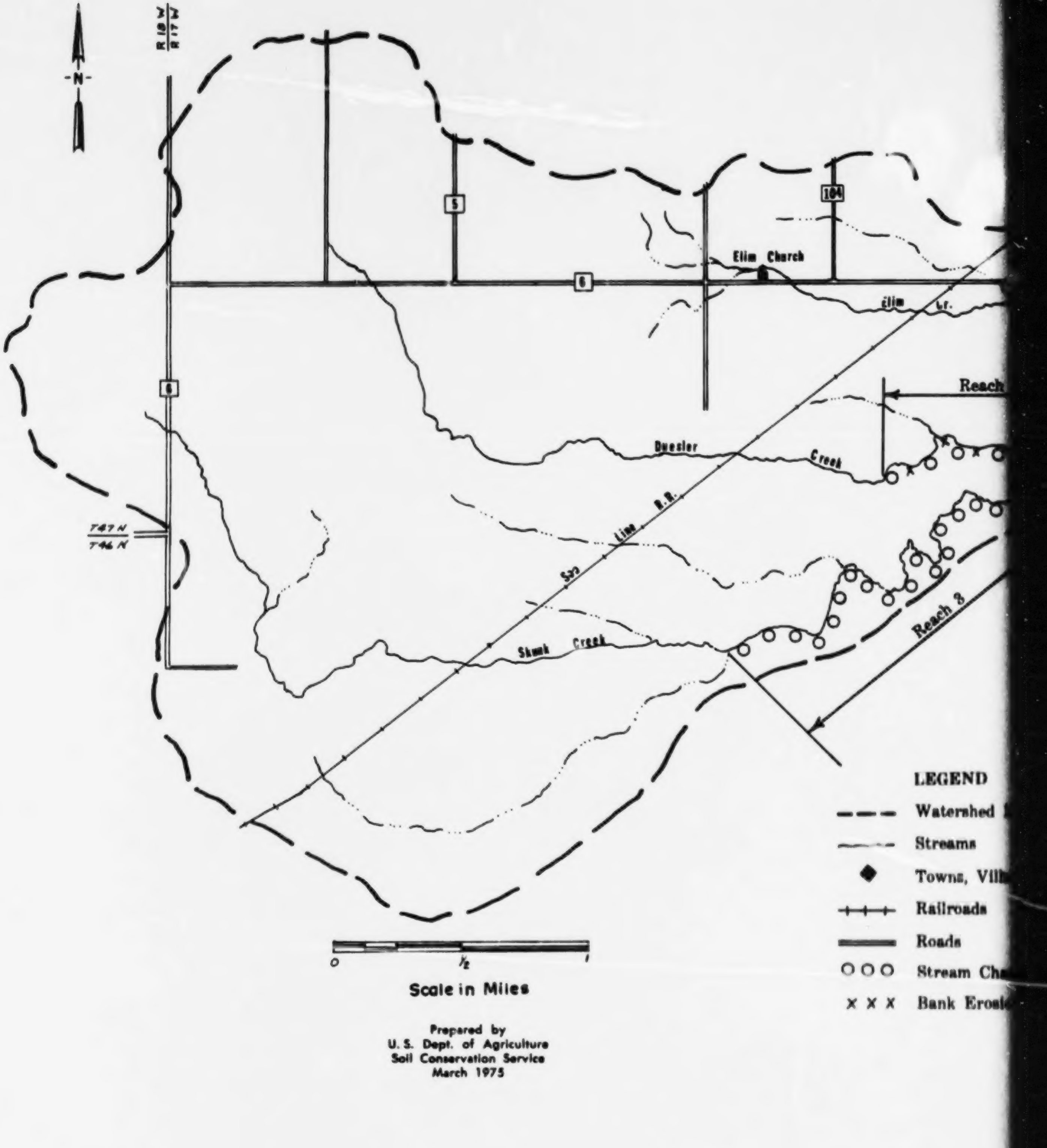
TABLE 6 STREAMBANK EROSION INVENTORY - SKUNK CREEK

Reach		Channel Description				Channel Erosion[2]	Slope Failure (Slides)				Other
									Slope Length		
No.	Straight Line Length (Ft)	Length (Ft)	Average Grade (Ft/Ft)	Vertical Depth[1] (Ft)	Average Side Slope (Ft:Ft)	Bank Length (Ft)	(No)	Length[3] (Ft)	Range (Ft)	Average (Ft)	
1 (main)	5,200	9,000	0.007	70-130	3:1 to 5:1	50	25	4,835	5-250	134	
1 (trib)		-	-	-	-	-	3	200	-	50	15' x 8' gully
2	7,400	11,000	0.009	30-70	5:1 to 6:1	2,040	22	2,400	5-250	56	-
3	7,200	11,000	0.004	20-40	5:1 to 10:1	1,800	0	0	-	-	-
4	3,500	5,400	0.012	30-70	4:1 to 6:1	800	22	1,870	5-300	84	30' x 2' x 2' gully

1 Vertical depth - as measured from the flat land to channel bottom

2 Less than 5 feet bank height

3 Slide length - measured parallel to the centerline of the stream



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Elim Cr.
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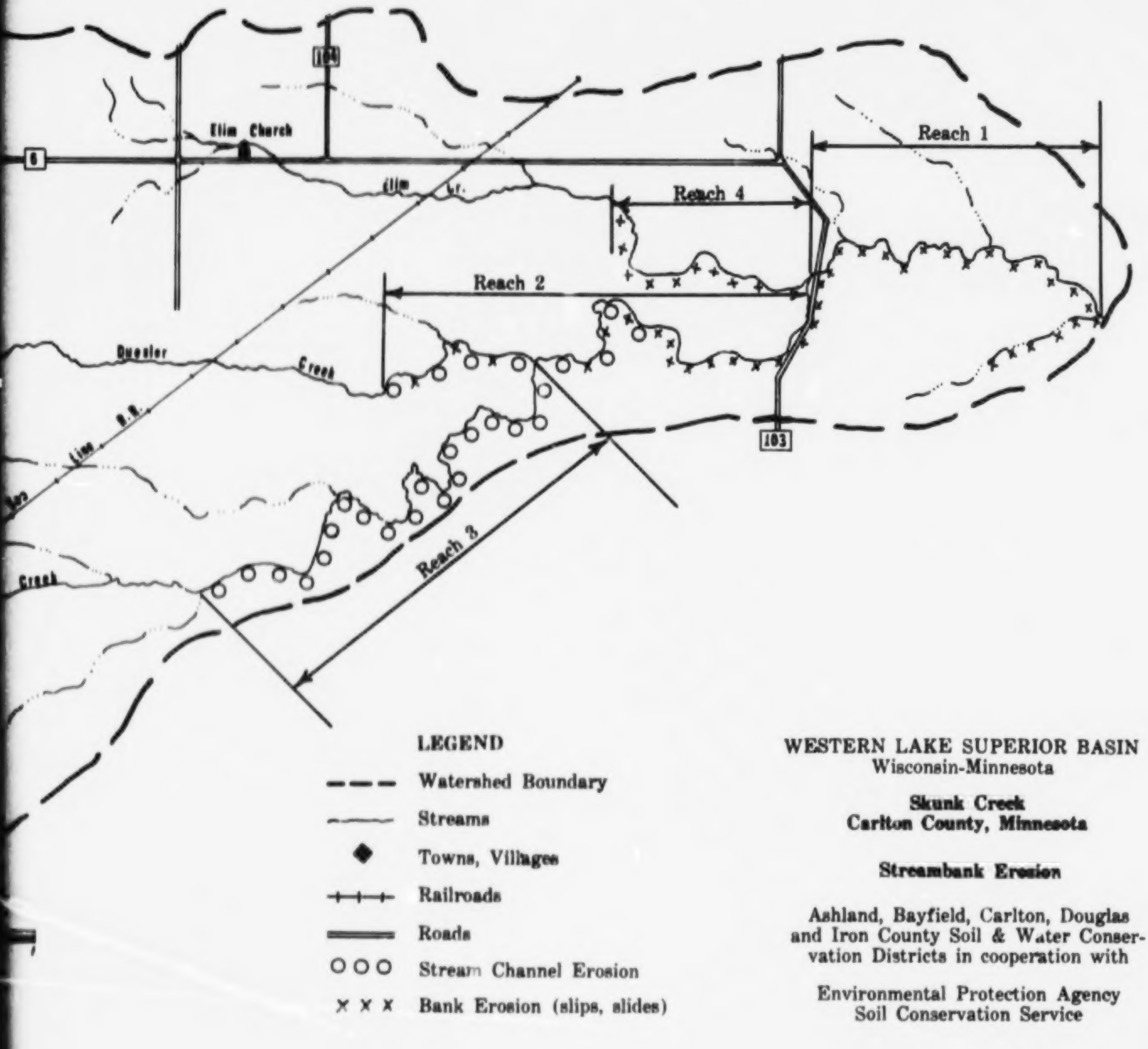
Scale in Miles

Prepared by
U.S. Dept. of Agriculture
Soil Conservation Service
March 1975


104
Elim Church
6
Elim Cr.
Reach 1
Reach 4
Reach 2
Duesler
Creek
Soo Line R.R.
103
Reach 3
Creek
LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads
Stream Channel Erosion
Bank Erosion (slips, slides)

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Skunk Creek
Carlton County, Minnesota

Streambank Erosion

Ashland, Bayfield, Carlton, Douglas and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

of Natural Resources. The SCS will assist designated specialists evaluate the effectiveness of land treatment measures.

The Districts will develop a catalog of applicable practices, establish cost share rates and adopt specifications. The financial cost sharing assistance by the District is needed to encourage the installation of practices with individual landowners. Cost share rates will be determined practice by practice by the District. The rate of cost sharing will be from 0% to 100% of total installation cost.

Demonstration

In addition to the proposed land treatment measures, the Soil and Water Conservation District's work will involve structural measures to stabilize slopes and reduce streambank erosion. Work will include: 1) Detailed site investigations including assessments of streambank erosion, soils, geology and foundation materials. 2) Field engineering surveys to determine precise structure site location and provide additional structure design data. 3) Supervision of installation of the structural measures. 4) Monitoring the effectiveness of structural measures by the Soil Conservation Service, United States Geological Survey and others.

Drop spillways, box inlets or hooded inlets will be used to stabilize natural or artificial channels or prevent the formation or advance of gullies. These grade stabilization structures will be formed of various combinations of concrete, galvanized culvert pipe, treated wood, masonry and sheet piling with earthen fill.

Land rights, operations and maintenance will be the responsibility of the District. The District shall obtain necessary permits from the Minnesota Department of Natural Resources to engage in stream related work.

A summary of the proposed Work Plan has been developed to show how the Soil and Water Conservation District plans to accomplish this goal. The Work Plan covers a period of 3 years. The costs and quantities of proposed work and technical assistance are shown in Table 7. A general time schedule is shown in Table 8.

Research

In the Skunk Creek study area research is proposed which will:

1. Identify the effects of erosion control measures on aquatic life. This will be accomplished by monitoring fish, aquatic insect population and water quality at selected sites above and below areas slated for bank stabilization.

2. Provide a picture of present and historical vegetative cover patterns which, when related to run-off data should identify the most effective vegetative cover for controlling erosion. This will be accomplished by examination of historical records, ground truthing of existing aerial photographs, identification of vegetational composition of the study area.

3. Identify the role of plant roots in retarding or accelerating erosion. This will be accomplished by monitoring and evaluating erosion areas and correlation of root distribution patterns along established transects.

4. Provide evidence that ground water flow may be causing or aggrevating soil instability. This will be accomplished by the carrying out of ground water studies by the United States Geological Survey.

Monitoring

1. Water Quality and Streamflow

At the present time there are no monitoring stations in the study area. It is hoped that early installation of the monitoring stations shown on the Work Location Map, page 32, will allow us sufficient pretreatment data to judge the effectiveness of the work planned. Two class "A" stations and one class "B" station will be installed in the Skunk Creek Study Area at locations where the most useful data may be generated. The description of these stations and the parameters to be measured are found in Appendix D. In addition to the three USGS stations, grab samples will be taken on an, as yet unspecified, grassed waterway. These samples will be analyzed for nutrient parameters.

2. Precipitation

The study of soil carried by runoff water requires a high density of precipitation measurements with useful resolution of rate over the dynamic range to be encountered. To overcome this problem, a low cost recording intensity of rainfall gauge coupled with a digital memory system will be installed on a one per square mile basis (15). In addition three wedge-type, total rainfall gauges will be placed in the basin for a comparison with measurement made with other gauges.

3. Soil and Air Temperature

The temperature of the soil at several depths and air temperatures will be measured with silicon type sensors. Three temperature recorders will be placed in the study area.

LAND TREATMENT NEEDS SKUNK CREEK

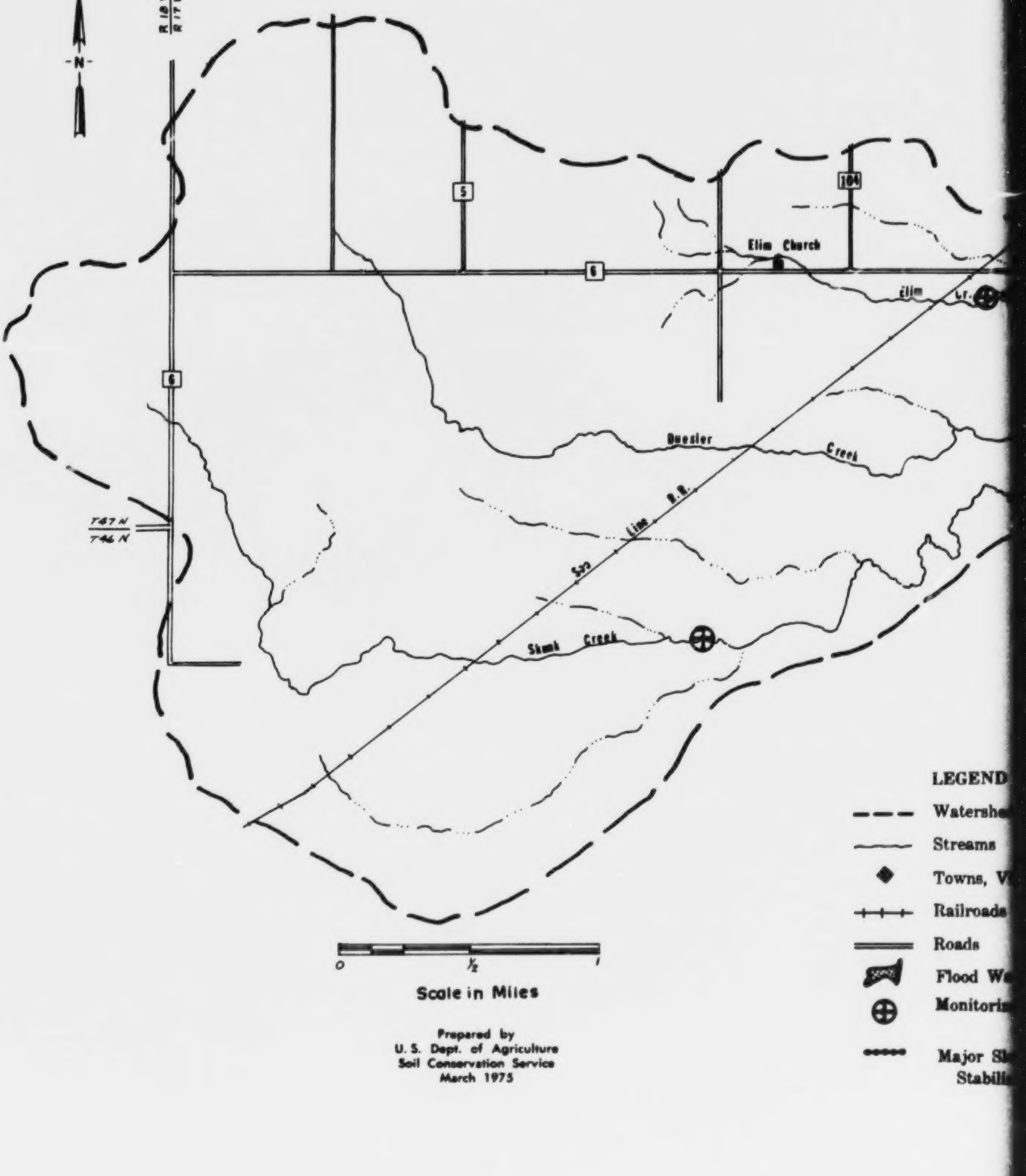
Need	Unit	Unit Cost $	Tech. Assist. Time/Unit MD's	Total Units Needed	Amount to Be Treated Under Ongoing Proj 3 yrs	Accelerated Treatment Under EPA Funds 3 yrs	Accelerated Costs Installation $	Accelerated Costs Tech. Assist. $
A. Management								
Conservation Plans	No.	-	5.0	25	10	15	-	$ 5,700.00
Conservation Plans	Ac.	-	-	5,000	2,000	3,000	-	-
District Cooperators	No.	-	0.1	25	10	15	-	100.00
District Cooperators	Ac.	-	-	5,000	2,000	3,000	-	-
Land Adequately Treated	Ac.	-	-	5,000	2,000	3,000	-	-
Livestock Exclusion	Ac.	-	-	1,000	600	400	-	-
Recreation Area Improvement	Ac.	-	1.0	20	8	12	-	800.00
Woodland Improvement	Ac.	-	0.01	100	20	80	-	50.00
Woodland Site Preparation	Ac.	-	0.01	500	400	100	-	50.00
B. Land Treatment Practices								
Access Roads	Ft.	$ 3.40	0.0005	23,000	2,000	21,000	$ 71,500	600.00
Animal Waste Systems	No.	7,000.00	12.5	6	2	4	28,035	5,950.00
Brush Management	Ac.	4.00	-	400	100	300	1,200	-
Conservation Cropping Systems	Ac.	2.00	-	1,000	400	600	1,200	-
Critical Area Planting	Ac.	700.00	1.5	5	2	3	2,100	300.00
Crop Residue Management	Ac.	1.50	0.05	100	50	50	75	50.00
Diversions	Ft.	.75	0.002	6,000	2,000	4,000	3,000	400.00

TABLE 7

Need	Unit	Unit Cost $	Tech. Assist. Time/Unit MD's	Total Units Needed	Amount to Be Treated Under Ongoing Proj 3 yrs	Accelerated Treatment Under EPA Funds 3 yrs	Accelerated Costs Installation $	Accelerated Costs Tech. Assist. $
Farmstead Windbreak	Ac.	100.00	0.5	6	2	4	400	100.00
Fencing	Ft.	.70	0.0002	90,000	40,000	50,000	35,000	500.00
Field Windbreak	Ft.	.20	0.0005	9,200	3,000	6,200	1,240	150.00
Flood Water Retention Structures	No.	150,000.00	530	1	-	1	150,000	42,500.00[1]
Grassed Waterways	Ac.	500.00	1.0	15	5	10	5,000	650.00
Pasture & Hayland Management	Ac.	20.00	0.06	1,000	500	500	10,000	1,500.00
Pasture and Hayland Planting	Ac.	80.00	0.06	200	100	100	8,000	300.00
Stock Trail and Walkway (water facility)	Ft.	23,00	0.01	800	400	400	6,750	200.00
Stripcropping	Ac.	10.00	0.01	10	10	-	-	-
Tree Planting	Ac.	100.00	0.02	500	400	100	10,000	100.00
C. Stream Channel Protection Slope Stabilization	Ft.	300.00	0.76	2,000	-	2,000	600,000	180,000.00[1]
TOTAL							$ 933,500	240,000.00

[1] Includes 15% of installation cost for drilling and laboratory soil analysis

TABLE 7 (Continued)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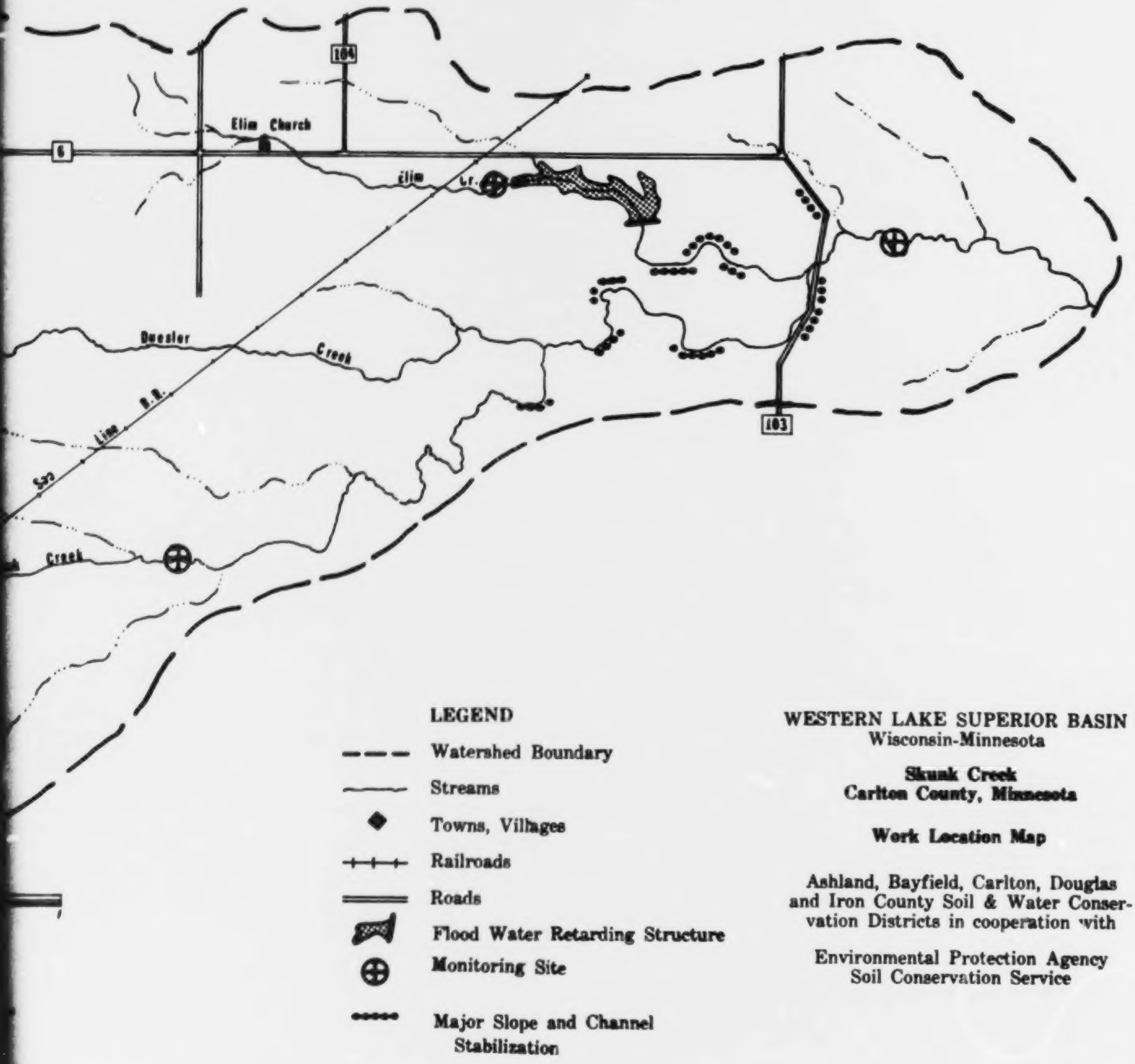
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975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Elim Church
6
Elim Cr.
Duesler Creek
Soo Line R.R.
Creek
103
LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads
Flood Water Retarding Structure
Monitoring Site
Major Slope and Channel Stabilization

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Skunk Creek
Carlton County, Minnesota

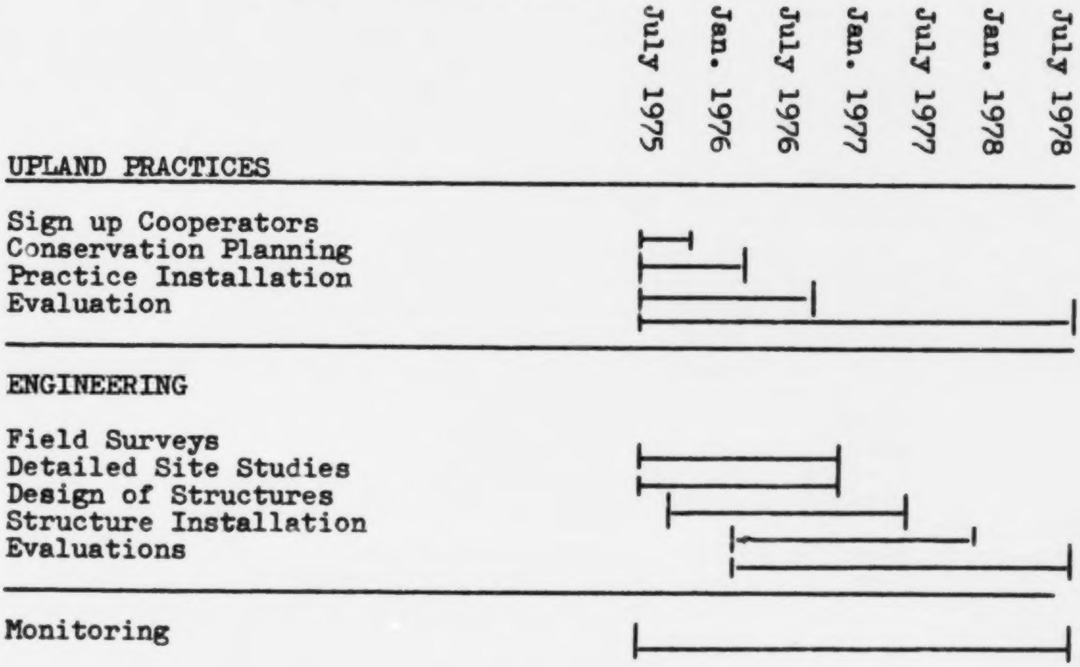
Work Location Map

Ashland, Bayfield, Carlton, Douglas and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

TABLE 8 WORK PLAN
TIME SCHEDULE

Skunk Creek Study Area



LITTLE BALSAM CREEK WATERSHED STUDY AREA

Description

The watershed comprises a drainage area of approximately 5.4 square miles (3,450 acres) in western Douglas County, Wisconsin, about 12 miles south of Superior. It is about 4 miles long and about 2.5 miles wide at the widest point. The stream has an overall average grade of 104 feet per mile. Little Balsam Creek originates about 2 miles south of the unincorporated village of Patzau. It flows in a northerly direction in 2 branches that join at the beach ridge. From here it flows northerly through the ridge to its junction with Balsam Creek about a half mile north of County Highway B. Two small tributaries join the stream near its outlet.

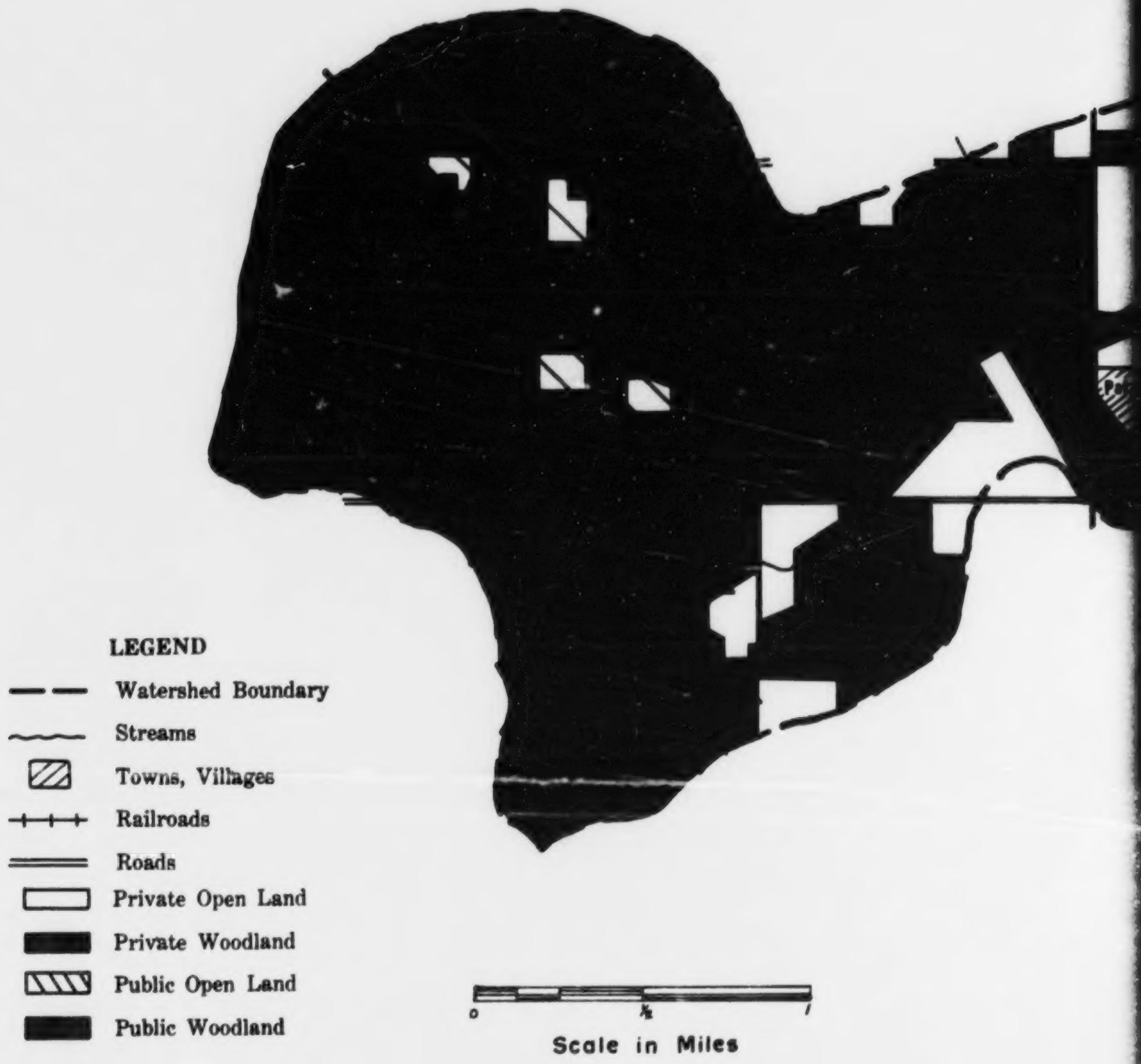
There are no major industrial or recreational sites. About 5% of the basin is cropland, 5% is open idle land, 2% is pastured woodland and the remaining 88% is woodland. The forest industry is an important part of the basin's economy, particularly of the upper part. It originally supported a coniferous forest. This was logged off and the land periodically burned. Aspen is the most abundant species today. Other species present are white birch, balsam fir and some elm. On the wetlands black spruce, black ash and northern white cedar are the dominant species. The map on page 35, illustrates land use and ownership in the Little Balsam Creek Basin.

The elevation of the watershed ranges from about 800 to 1,210 feet above sea level. It is partly within the lake laid sediments of glacial Lake Duluth and partly in drift. Surface deposits in the northern part consist mainly of lacustrine clay with some silt and fine sand layers. A prominent sandy glacial beach divides the watershed near the village of Patzau. South of this beach a till plain rises in elevation about 150 feet in a half mile, then levels to an undulating ground moraine with little relief. Little Balsam Creek originates in the numerous swamps and marshes on this till plain.

The underlying bedrock are the undifferentiated Middle Keweenawan volcanic formations of Precambrian Age. These are mainly basalt and andesite flows with interbedded sandstones, shales and conglomerates. The Douglas fault runs through the lower end of the watershed and coincides with the glacial beach but no evidence of modern movement is on record. Glacial drift overlies the bedrock in the upper part of the watershed. This drift, in the form of ground and end moraines, is generally sandy.

Streambank Erosion

Streambank erosion data in the Little Balsam Creek study area was collected by field survey. For the purpose of this study, erosion sites were identified by: 1) fresh exposure of soil or


LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads
Private Open Land
Private Woodland
Public Open Land
Public Woodland
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Scale in Miles

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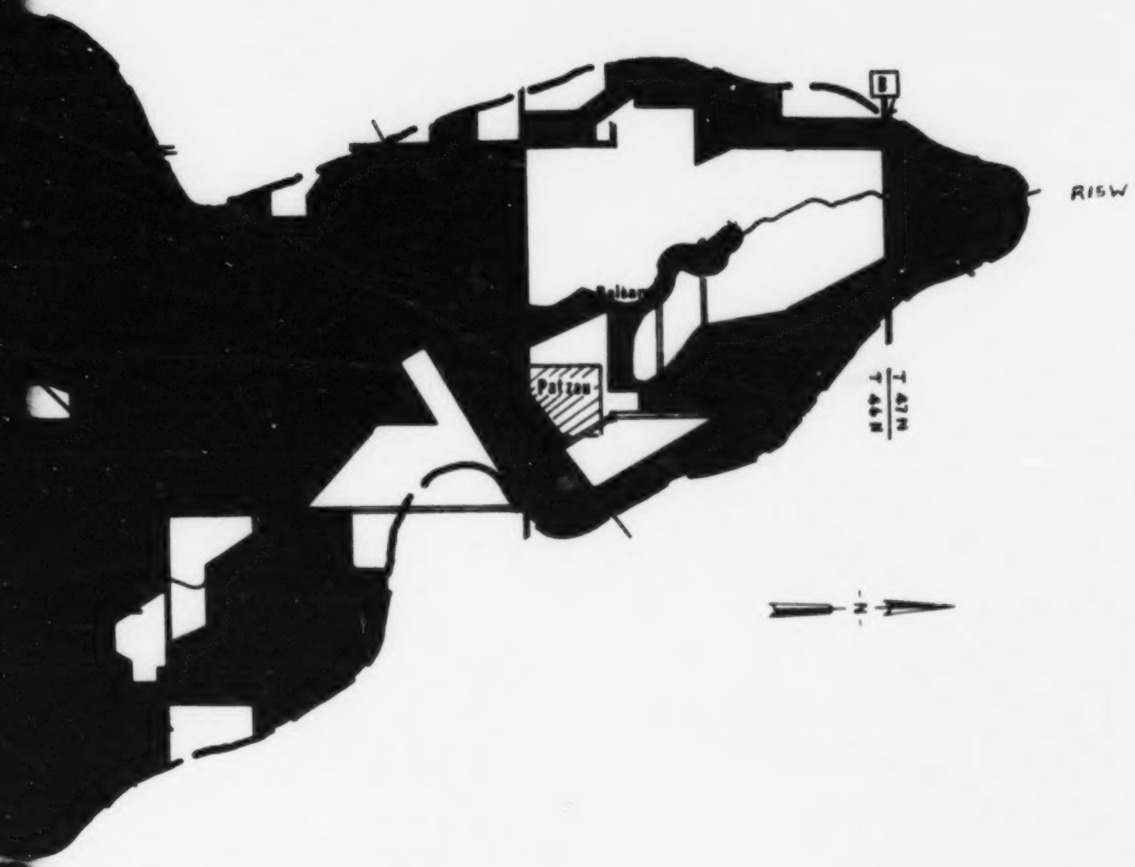
Soil Conservation Service
March 1975



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WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Little Balsam Creek Basin
Douglas County, Wisconsin

Land Ownership Map

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

alluvium, 2) scarcity or absence of vegetation, 3) recent evidence of slumping or movement, and 4) other visible signs of recent erosion. Table 10 and the accompanying map on page 39 is a summary of the streambank erosion inventory.

Land Capability Units

The land capability unit represents groupings of soils with common limitations for agricultural and woodland uses. The soils within each unit show similar response to like treatment under similar use patterns.

The capability groupings presented here are intended for use in this report only.

There are 38 different kinds of soil in the Little Balsam, Wisconsin study area. These soils make up a total of 18 land capability units which are used in determining land treatment needs. A more detailed description of the soils in each capability unit, their characteristics and limitations are contained in Appendix A. The major soils within each land capability unit are listed in Table 9. The land capability unit distribution pattern is shown on page 38.

TABLE 9
Soils Data By Land Capability

	Acreage	Major Soil Series	Major Hazard	Slopes (%)
IIe1	500	Gogebic	Erosion	2-6
IIe2	309	Ontonagon	Erosion	2-6
IIs1	198	Ontonagon	Ponded Water	0-2
IIw1	220	Tula	Wetness	0-3
IIIe1	222	Gogebic	Erosion	6-12
IIIe2	27	Ontonagon	Erosion	6-12
IIIe3	231	Washburn, Marenisco	Erosion	2-12
IIIw1	63	Rudyard Bergland	Wetness	0-2
IIIw3	25	Allendale	Wetness	0-2
IVe2	152	Ontonagon	Erosion	12-20
IVe3	441	Washburn, Marenisco	Erosion	6-12
IVs1	65	Vilas, Bibon	Drouthiness	2-6
IVw1	360	Rifle	Wetness	0-2
VIe1	167	Washburn, Marenisco	Erosion	12-20
VIs1	220	Vilas	Drouthiness	2-12
VIIe1	65	Steep Clayey Land	Erosion	30-45
VIIs1	10	Vilas	Erosion/ Drouthiness	12-20
VIIw1	175	Greenwood	Wetness	0-2

STREAMBANK EROSION INVENTORY - LITTLE BALSAM
TABLE 10

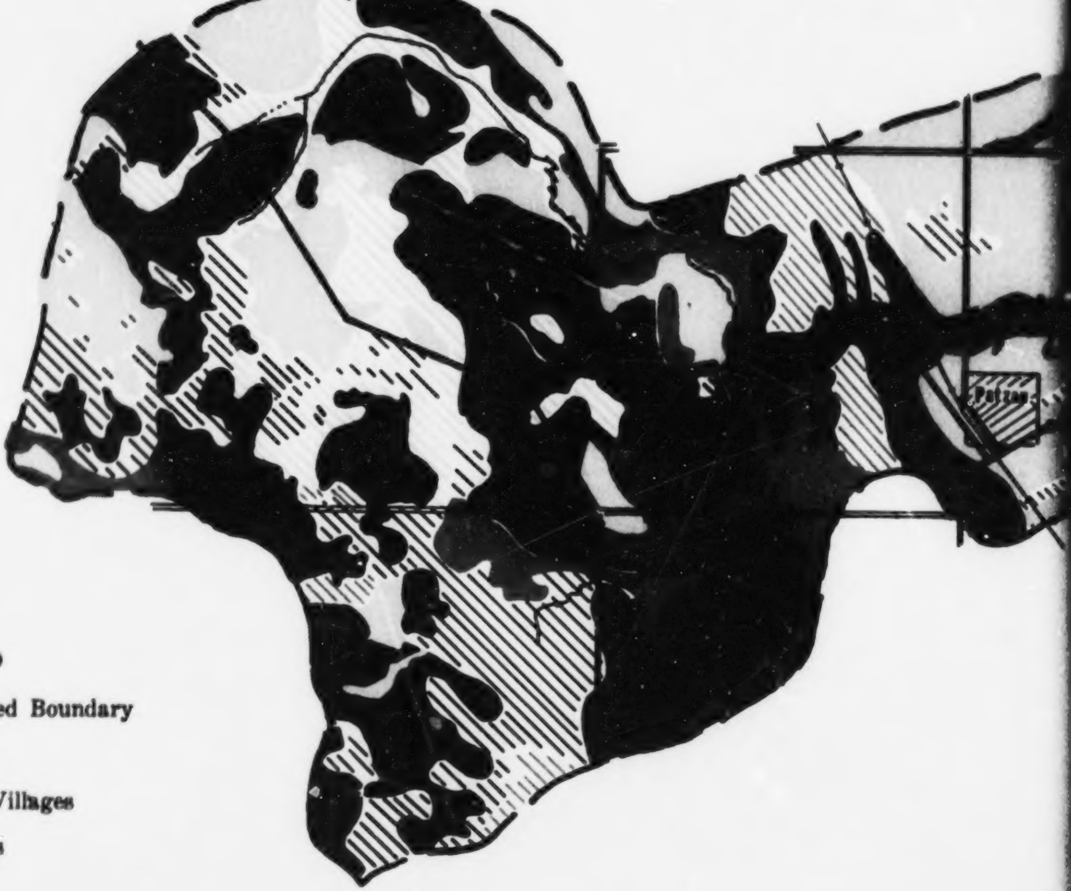
Reach		Channel Description				Channel Erosion	Slope Failure (Slides)				Other
									Slope Length		
No.	Straight Line Length (Ft)	Length (Ft)	Average Grade (Ft/Ft)	Vertical Depth[1] (Ft)	Average Side Slope (Ft:Ft)	Bank Length[2] (Ft)	(No)	Length[3] (Ft)	Range (Ft)	Average (Ft)	
1 (main)	2,200	3,300	0.015	60	4:1 to 8:1	80	12	800	5-150	59	
1 (trib)			0.024	-	4:1 to 6:1	-	5	510	12-80	48	
2	3,200	3,300	0.018	-	5:1 to 8:1	135	8	510	8-100	56	
3	2,600	3,100	0.018	-	Steep	24	2	65	8-25	18	
4	2,500	3,100	0.021	80-100	-	290[4]	3	190	25-50	39	
5	2,700	4,000	0.031	20-50	-	105[4]	-	-	-	-	

[1] Vertical depth - as measured from the flat upland to channel bottom

[2] Less than 5 feet bank height

[3] Slide length - as measured parallel to the centerline of the stream

[4] Raw banks may be as high as 25 ft in these reaches



LEGEND

— —	Watershed Boundary
∼∼∼	Streams
▨	Towns, Villages
┼┼┼	Railroads
═	Roads
▭	Class IIe and IIs
▭	Class IIw
■	Class IIIe
▨	Class IIIw
■	Class IVe and IVs
▨	Class IVw
■	Class VIe and VIs
▨	Class VIw
■	Class VIIe and VIIs
▨	Class VIIw

Scale in Miles

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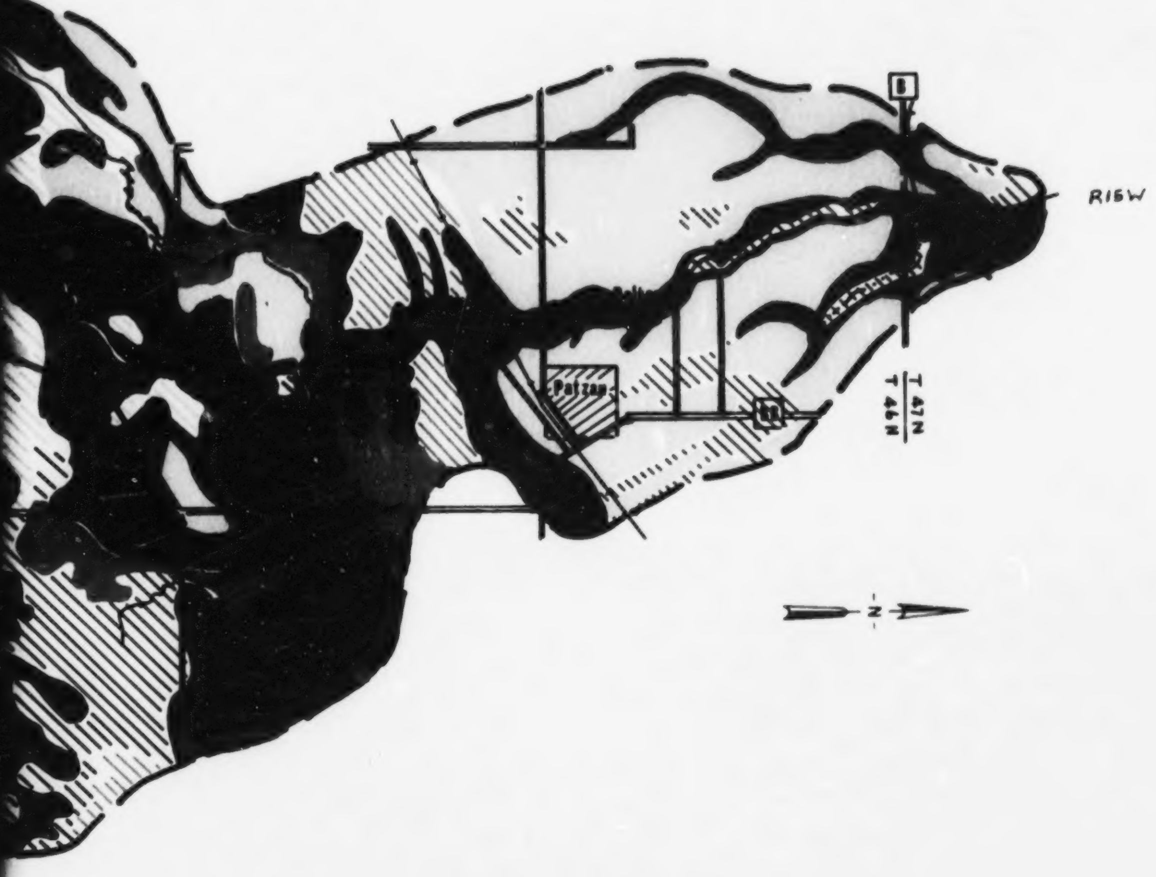
March 1975



WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Little Balsam Creek Basin
Douglas County, Wisconsin

Land Capability Map

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conser-
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Environmental Protection Agency
Soil Conservation Service

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March 1975

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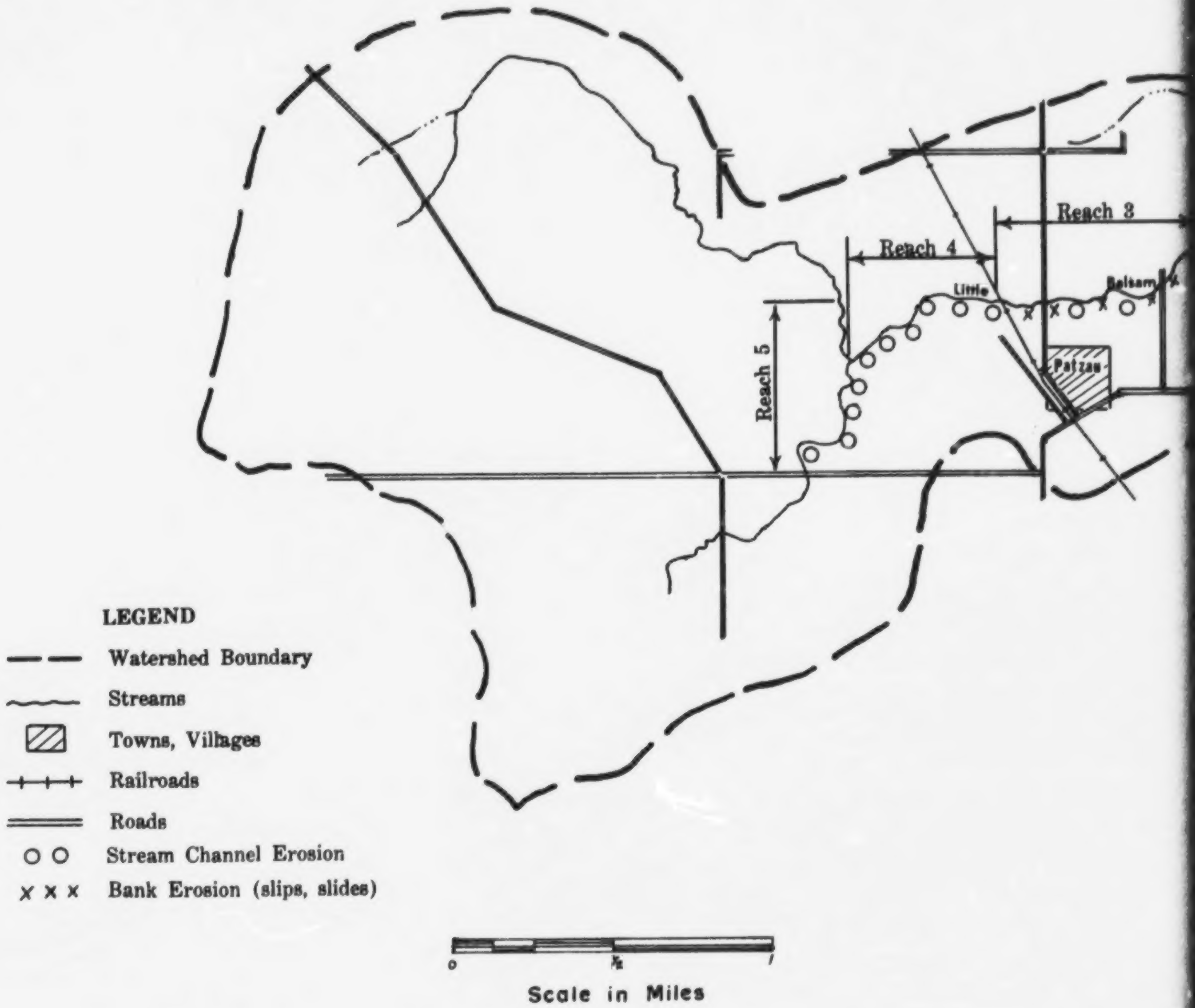
Reach 3
Reach 4
Reach 5
Little
Balsam
Patzau
LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads
Stream Channel Erosion
Bank Erosion (slips, slides)
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1
Scale in Miles

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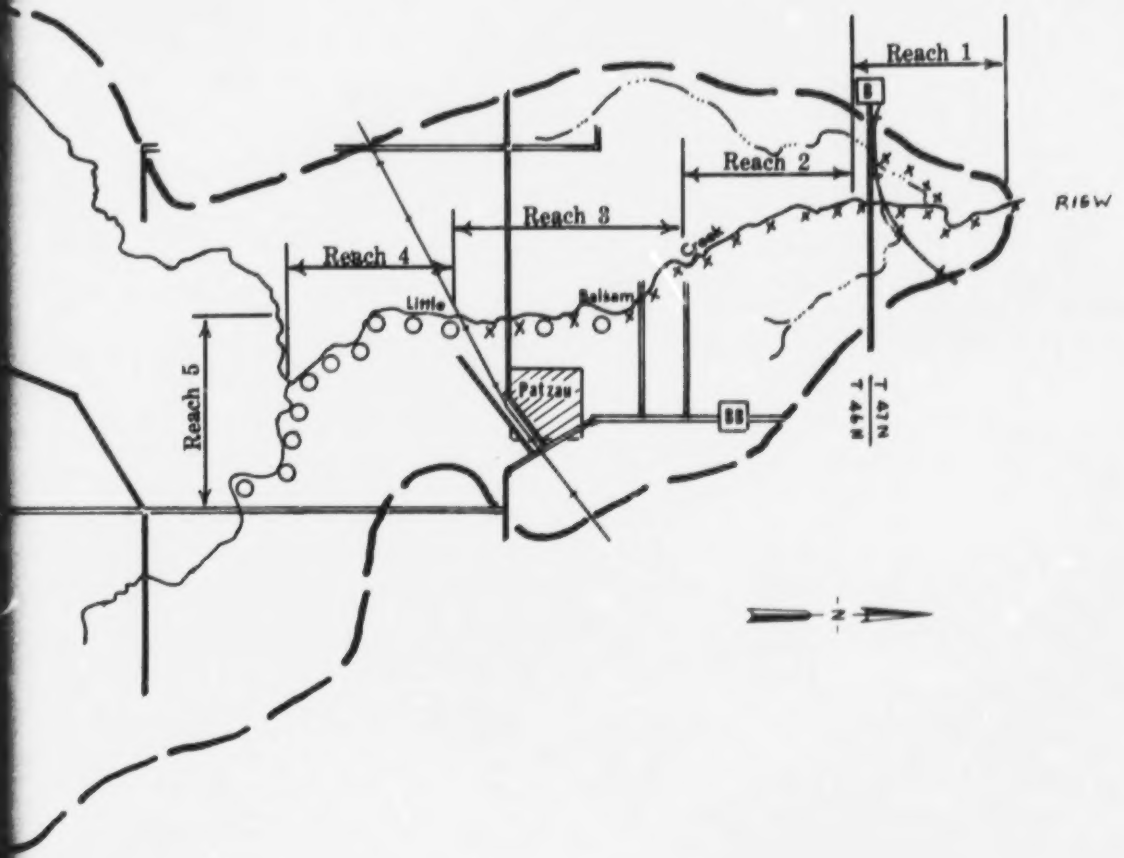
Soil Conservation Service
March 1975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WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Little Balsam Creek Basin
Douglas County, Wisconsin

Streambank Erosion

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

Land Treatment Needs

An analysis of the study area was made to identify the types and amount of land treatment needs to reduce soil erosion.

This study was completed by Soil Conservation Service personnel based on established procedures. No attempt was made during the study period to plan systems of treatment for individual landowners.

Table 11 lists the various practices and cost schedule which should be applied in the study area to achieve adequate land treatment and erosion control. It should be pointed out that success of this program will depend on planning with individual landowners and Sponsors. It is anticipated that this treatment of the area will allow an accurate assessment of the effect of the program on water quality.

Table 12, page 46, is the schedule for achieving this treatment over a three year period. The Work Location Map is on page 45. The practices listed are briefly described in Appendix C. The amounts listed are in addition to practices currently applied in the study area.

The S.C.S. will assist the Soil and Water Conservation Districts in signing up landowners as district cooperators within the study areas. This will indicate the extent of local cooperation to be expected and will provide an opportunity to further explain the sediment reduction program. It also provides the means by which the S.C.S. is authorized to provide technical assistance to local landowners within the study area.

A conservation plan will be developed with each cooperator with the assistance of the S.C.S. The conservation plan is a record of the land treatment measures the landowner agrees to apply, the amount of each measure and the projected date of installation. This plan will also serve as the basis for financial cost sharing on the installation of erosion control measures. Installation of selected measures will be carried out by the cooperator with techncial assistance from the S.C.S. staff and cost sharing assistance from the S.W.C.D. Landowners that require forestry technical services will be assisted by the Wisconsin Department of Natural Resources. The S.C.S. will assist designated specialist evaluate the effectiveness of land treatment measures.

The Districts will develop a catalog of applicable practices, establish cost share rates and adopt specifications. The financial cost sharing assistance by the District is needed to encourage the installation of practices with individual landowners. Cost share rates will be determined practice by practice by the District. The rate of cost sharing will be from 0% to 100% of total installation cost.

The majority of the S.W.C.D. work will involve structural measures to stabilize slopes and reduce streambank erosion. Work will involve: 1) Detailed site evaluation prior to design or installation of structural works. Streambank erosion, soils, geology and foundation materials will be assessed in greater detail. 2) Field surveys to determine precise structure site locations and provide data for structure design. 3) Supervision during installation of structural measures. 4) Monitoring the effectiveness of the structural measures by S.C.S., U.S.G.S. and others.

Operations, maintenance and land-rights acquisition will be the responsibility of the Sponsors. The District shall obtain necessary permits to do stream channel work from Wisconsin Department of Natural Resources.

Control of roadside erosion will require engineering surveys to guide design and installation. Land shaping, grade stabilization structures and revegetation is needed for erosion control. Drop spillways, box inlets or hooded inlets will be used to stabilize natural or artificial channels or prevent the formation or advance of gullies. These grade stabilization structures will be formed of various combinations of concrete, galvanized culvert pipe, treated wood, masonry and sheet piling with earthen fill. S.C.S. and the Department of Transportation will assist with planning and installation of roadside treatment measures. Sponsors will obtain necessary land-rights.

A summary of the proposed Work Plan has been developed to show how the Soil and Water Conservation District plans to accomplish this goal. The Work Plan covers a period of 3 years. The costs and quantity of proposed work and technical assistance needed are shown in Table 11. A general time schedule is provided in Table 12.

Soil Surveys

Soil surveys will provide basic background data for the planning and implementation of land treatment, land use regulation and structural measures contained herein. In addition, the survey will aid in assessing the magnitude of erosion and treatment needs for the entire project area.

These soil surveys will be completed by a survey team supervised by the S.C.S. Standard soil survey procedures will be followed. Soil - Woodland site index studies will be completed to guide soil interpretation. Soil sampling and analyses will be carried out as needed. A handbook of soil properties and limitations will be developed to assist land uses in each survey area.

About 47,000 acres remain to be surveyed in the Wisconsin portion of the Nemadji Basin. This will be completed during the 1975-76 field season.

Research

In the Little Balsam Creek Study Area research is proposed which will:

1. Identify the effects of erosion control measures on aquatic life. This will be accomplished by monitoring fish and aquatic insect population and water quality at selected sites above and below areas slated for bank stabilization.

2. Provide a picture of present and historical vegetative cover patterns which, when related to runoff data should identify the most effective vegetative cover for controlling erosion. This will be accomplished by examination of historical records, ground truthing of existing aerial photographs, identification of vegetational composition of the study area.

3. Identify the role of plant roots in retarding or accelerating erosion. This will be accomplished by monitoring and evaluating erosion areas and correlation of root distribution patterns along established transects.

4. Provide data concerning those plants (both natural and planted) which are most effective in serving as soil moisture "pumps" and thus aiding red clay stability. This will be accomplished by monitoring weather elements, soil moisture, runoff and seepage on plots of typical vegetation types.

5. Provide an objective summary of slope conditions as they exist within the study area and assess the condition and behavior of soils within the zone normally involved in slope failure and erosion. This will be accomplished through analysis of slope morphometry and the physical/chemical properties of sediments obtained from core samples.

Monitoring

1. Water Quality and Streamflow

At the present time there are no monitoring stations in the study area. It is hoped that early installation of the monitoring stations shown on the Work Location Map, page 45, will allow us sufficient pretreatment data to judge the effectiveness of the work planned. Two class "A" stations and one class "B" station will be installed in the Little Balsam Creek Study Area at locations where the most useful data may be generated. The description of these stations and the parameters to be measured are found in Appendix D. In addition to the three USGS stations, grab samples will be taken on an, as yet unspecified, grassed waterway. These samples will be analyzed for nutrient parameters.

2. Precipitation

The study of soil carried by runoff water requires a high density of precipitation measurements with useful resolution of rate over the dynamic range to be encountered. To overcome this problem, a low cost recording intensity of rainfall gauge coupled with a digital memory system will be installed on a one per square mile basis (10). In addition three wedge-type, total rainfall gauges will be placed in the basin for a comparison with measurement made with other gauges.

3. Soil and Air Temperature

The temperature of the soil at several depths and air temperatures will be measured with silicon type sensors. Three temperature recorders will be placed in the study area.

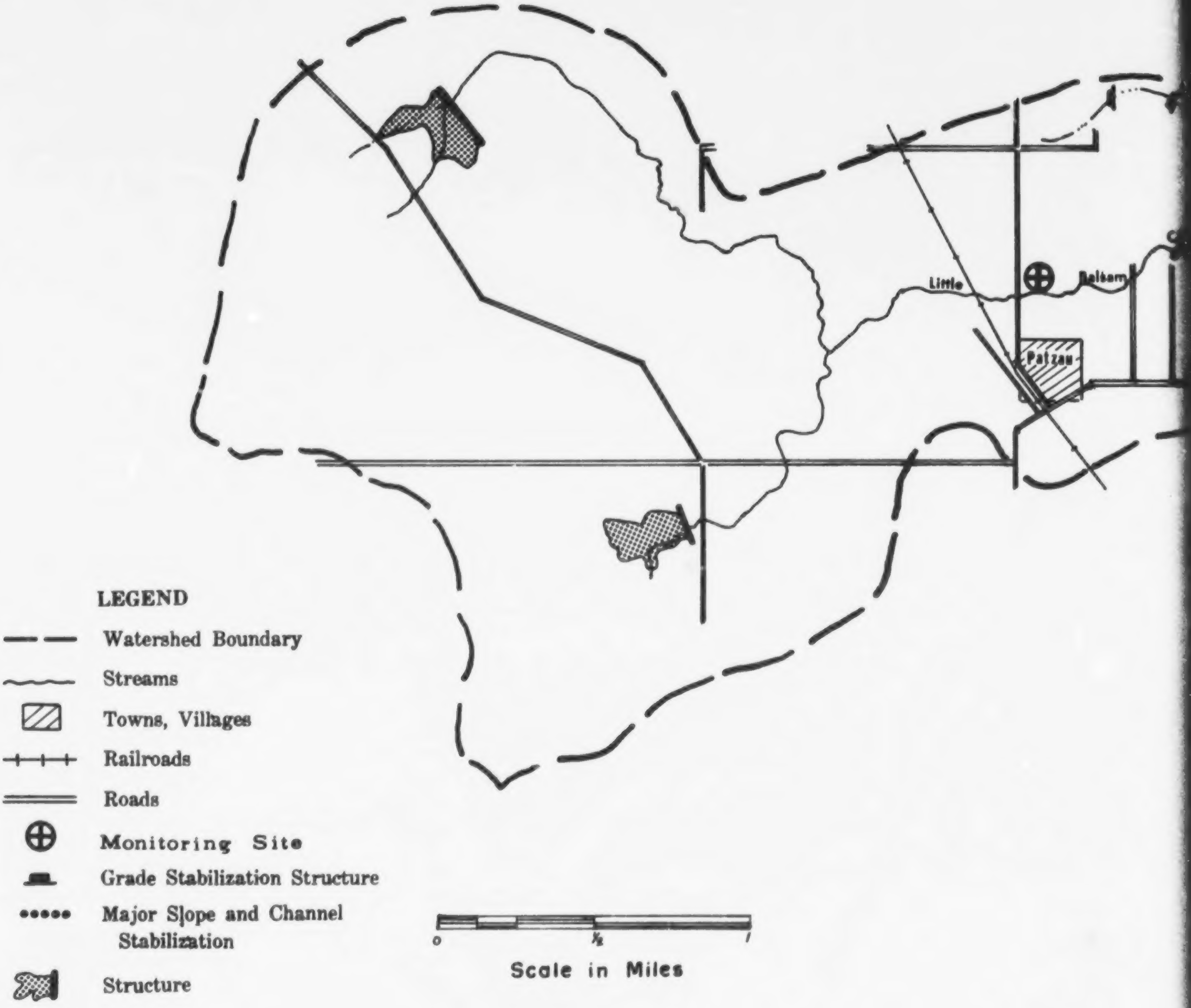
LAND TREATMENT NEEDS LITTLE BALSAM CREEK

Need	Unit	Unit Cost $	Tech. Assist. Time/Unit MD's	Total Units Needed	Amount to Be Treated Under Ongoing Proj 3 yrs	Accelerated Treatment Under EPA Funds 3 yrs	Accelerated Costs	
							Installation $	Tech. Assist. $
A. Management								
Conservation Plans	No.	-	5.0	26	2	24	-	9,100
Conservation Plans	Ac.	-	-	2,600	400	2,200	-	-
Conservation Plan Rev.	No.	-	3.0	3	1	2	-	300
Conservation Plan Rev.	Ac.	-	-	850	150	700	-	-
District Cooperators	No.	-	0.1	26	2	24	-	150
District Cooperators	Ac.	-	-	2,600	400	2,200	-	-
Land Adequately Treated	Ac.	-	-	1,600	200	1,400	-	-
Livestock Exclusion	Ac.							
Recreation Area Improvement	Ac.							
Woodland Site Preparation	Ac.	-	0.01	40	5	35	-	50
B. Land Treatment Practices								
Access Roads	Ft.	3.40	0.0005	13,000	-	13,000	44,200	400
Brush Management	Ac.	4.00	-	50	10	40	160	-
Conservation Cropping System	Ac.	2.00	-	180	40	140	280	-
Critical Area Planting	Ac.	700.00	1.5	3	0	3	2,100	-
Drainage Field Ditch	Ft.	0.40	0.0008	15,000	1,500	13,500	5,400	700
Fencing	Ft.	0.70	0.0002	10,000	-	10,000	7,000	100

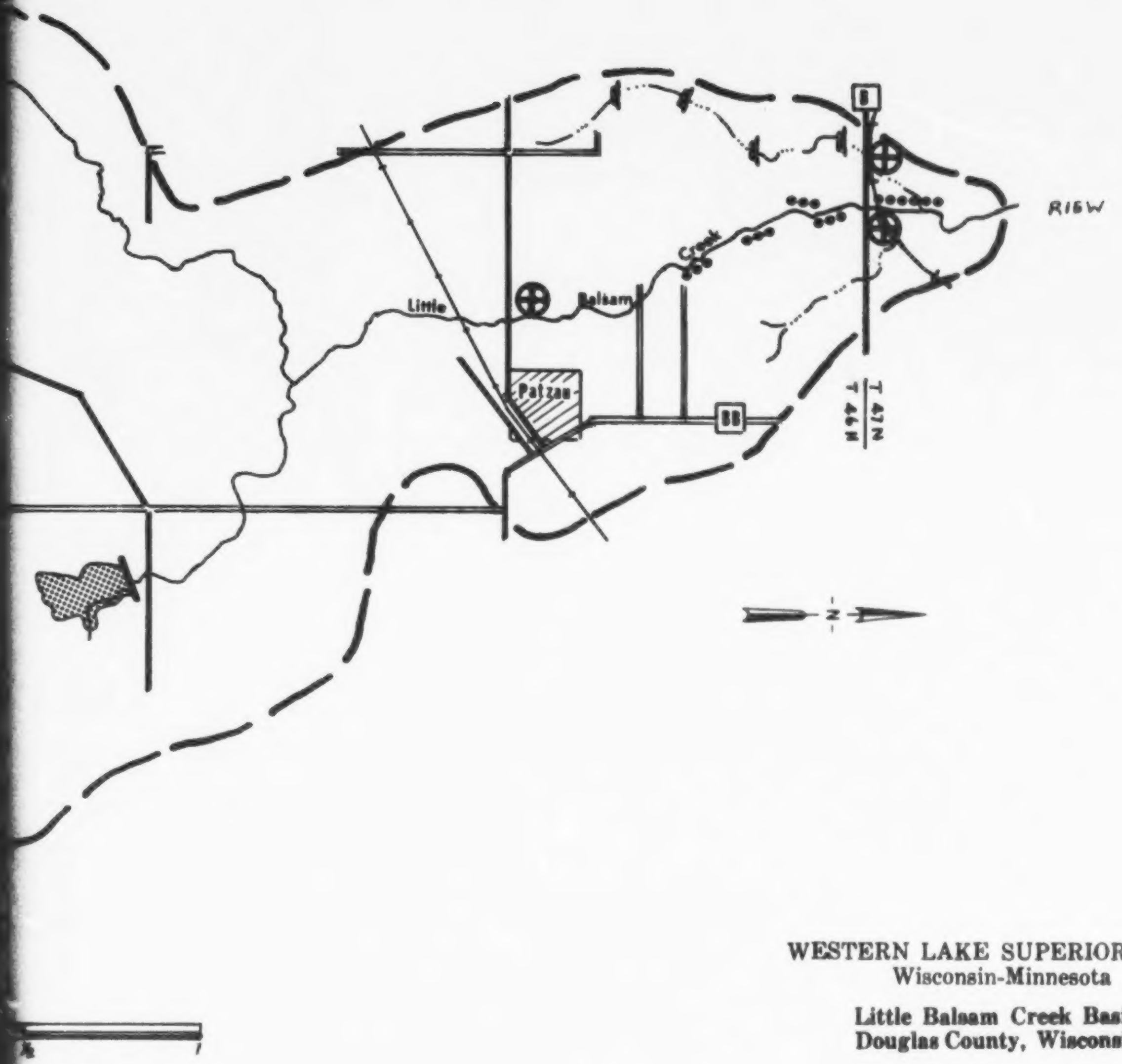
TABLE 11

Need	Unit	Unit Cost $	Tech. Assist. Time/Unit MD's	Total Units Needed	Amount to Be Treated Under Ongoing Proj 3 yrs	Accelerated Treatment Under EPA Funds 3 yrs	Accelerated Costs Installation $	Accelerated Costs Tech. Assist. $
Flood Water Retention Structures	No.	Variable	73.5	2	-	2	50,000	17,100
Grade Stabilization (channel)	No.	15,000.00	67.6	4	-	4	60,000	29,000
Grade Stabilization (gully)	No.	7,000.00	25.9	4	-	4	28,000	10,000
Grass Waterways	Ac.	500.00	2.0	2	-	2	1,000	250
Land Smoothing	Ac.	25.00	0.03	180	10	170	4,260	350
Pasture & Hayland Management	Ac.	20.00	0.06	40	-	40	800	150
Pasture & Hayland Planting	Ac.	80.00	0.06	40	10	30	2,400	100
Stock Trail & Walkway (watering facility)	Ft.	23.00	0.01	400	-	400	9,200	200
Tree Planting	Ac.	100.00	0.02	50	5	45	4,500	50
C. Stream Channel Protection & Slope Stabilization	Ft.	300.00	0.76	500	-	500	150,000	44,000
							$369,300	$112,000

TABLE 11 (Continued)


Little
Balsam
Patzau
LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads
Monitoring Site
Grade Stabilization Structure
Major Slope and Channel Stabilization
Structure
0
½
1
Scale in Miles

Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975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WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

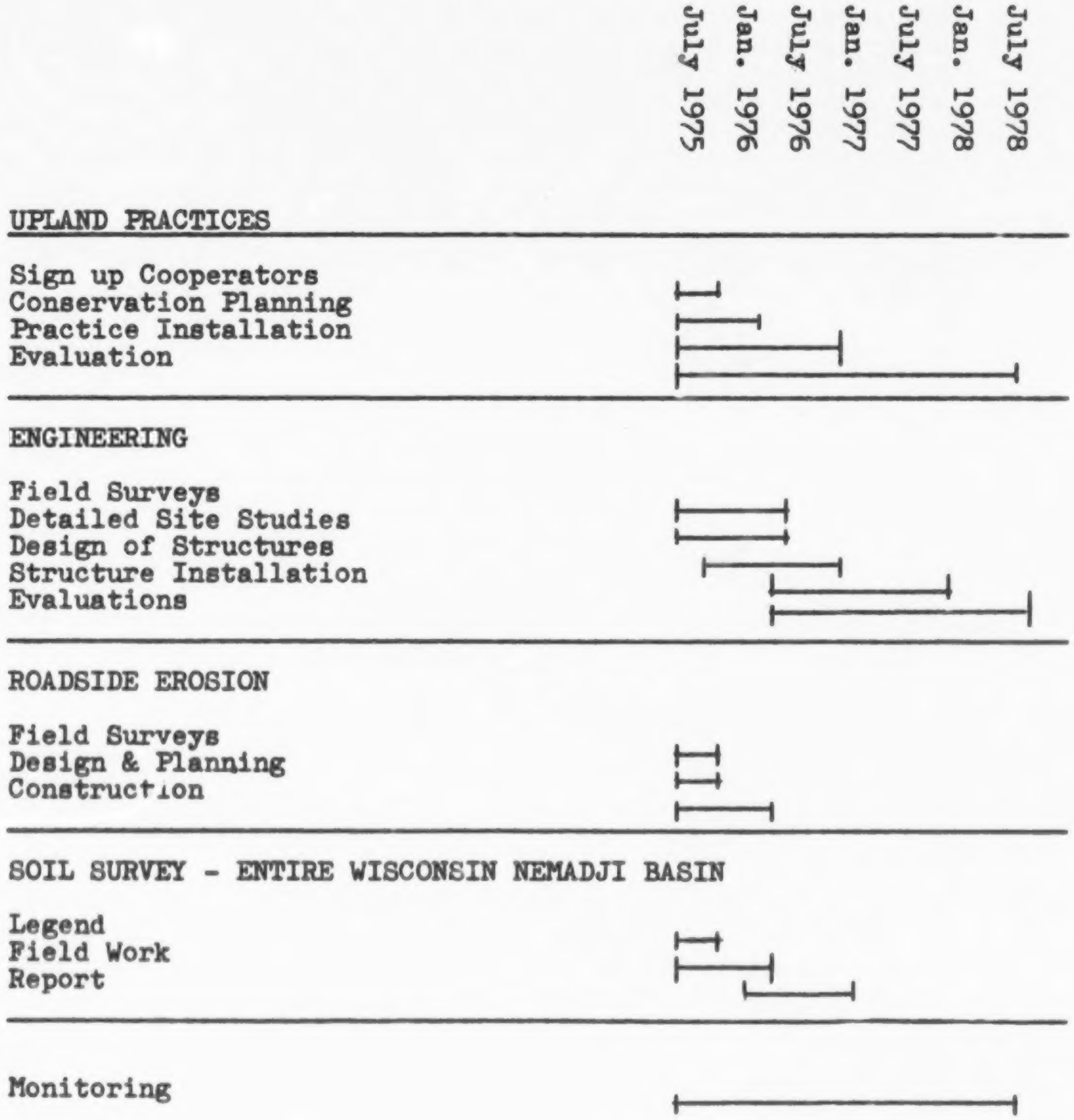
Little Balsam Creek Basin
Douglas County, Wisconsin

Work Location Map

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conser-
vation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

TABLE 12 WORK PLAN
TIME SCHEDULE
Little Balsam Study Area



IV. FISH CREEK WATERSHED

Description

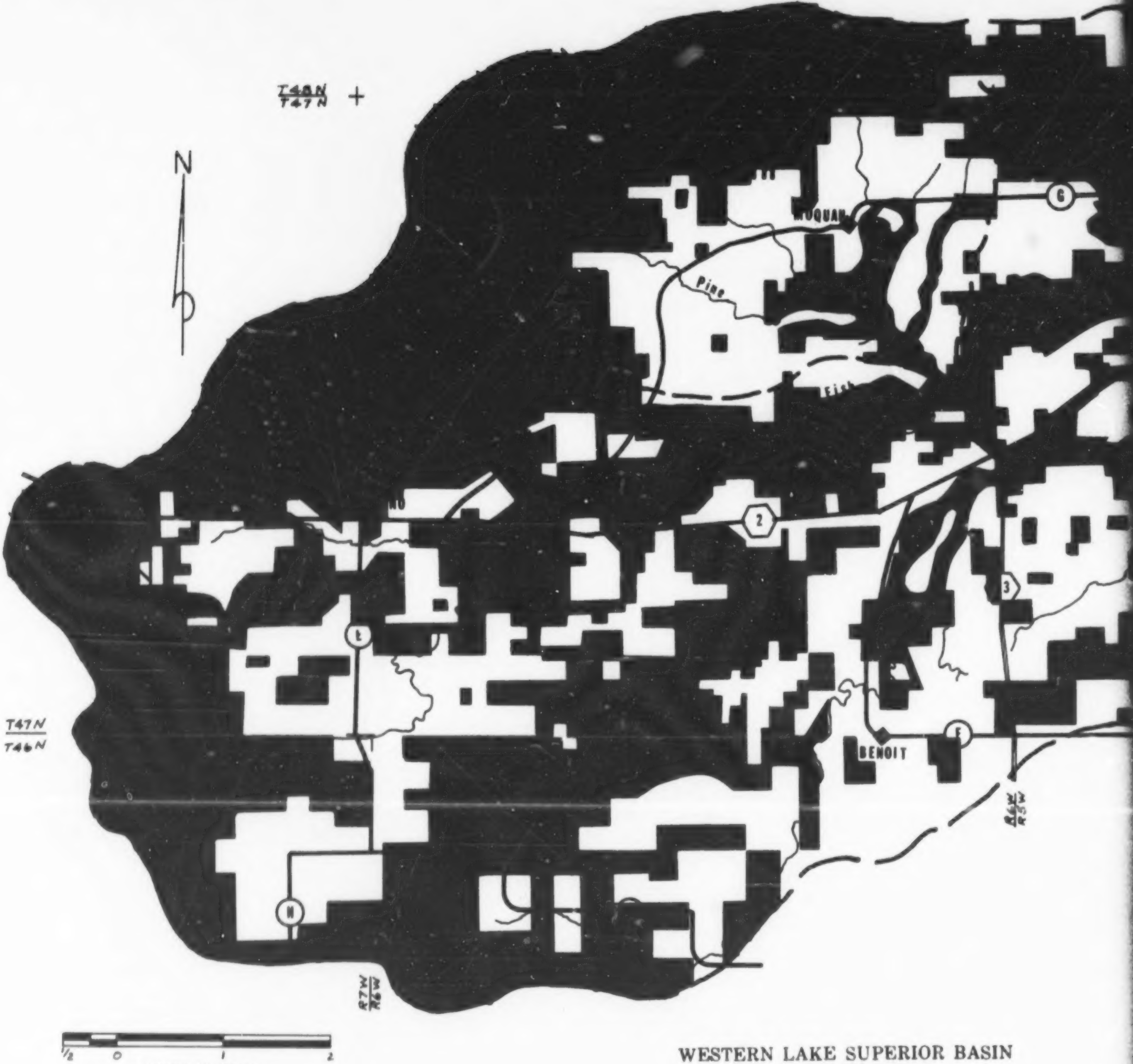
North Fish Creek begins near Spider Lake and flows northeastward entering Lake Superior about 2 miles west of Ashland. It has contributing inflow from Pine Creek south of Moquah, and South Fish Creek entering the main stream near Lake Superior. Fish Creek and its tributary system drains a total of 93.3 square miles (59,720 acres). It is an entrenched stream throughout most of its length, particularly in midcourse where it flows as much as 100 feet below the general level of the lacustrine plain. North Fish Creek, the main stream, is 21.0 miles in length and has an average gradient of 25.6 feet per mile. Drainage characteristics of the basin are good with the exception of the last two miles of the flood plain which is quite swampy. During periods of high water, this part of the creek will overflow its banks and flood large areas, including portions of U.S. Highway 2.

The climate is largely continental, but it is modified by the tempering influence of Lake Superior and by local variations in topography. The average frost-free season is 116 days, but it is longer at some places along the shore of the lake. Average annual precipitation is 29 to 31 inches, most of which falls in summer. Frost penetrates the soils to a depth of 3 to 4 feet when they are not protected by snow. Dense fog occurs about 30 days annually along the shores of Lake Superior, less frequently inland. There are about 110 clear days and 140 cloudy days each year.

The entire basin had a 1970 population base of approximately 1,000 inhabitants, with a density distribution of about 6.7 people per square mile. The basin is rural with no major population centers, but several small communities typified by Benoit, Moquah and Ino do exist. The Land Use and Ownership Map is on page 48.

The main highways located in the basin are U.S. Highway 63 and 2. The former traverses in a north-south direction and the latter in an east-west direction. U.S. Highway 2 crosses Fish Creek in three localities; near its mouth, near the University of Wisconsin Experimental Farm at Ashland Junction, and near the community of Ino in the upper extremities of the North Fork. Highway 63 crosses the South Fish Creek south of the junction with Highway 2. No major recreational or industrial sites are located in this basin. One small cheese factory is located in Moquah.

Both the North and South Forks drain a substantial amount of farmland in the Benoit and Moquah areas. The 1965 Conservation Needs Inventory indicates that about 27% of the basin is cropland, 5% is continuous pasture, 2% is wetland, 59% is woodland


T48N
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R5W
R7W
R6W
½ 0 1 2
SCALE IN MILES

Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975

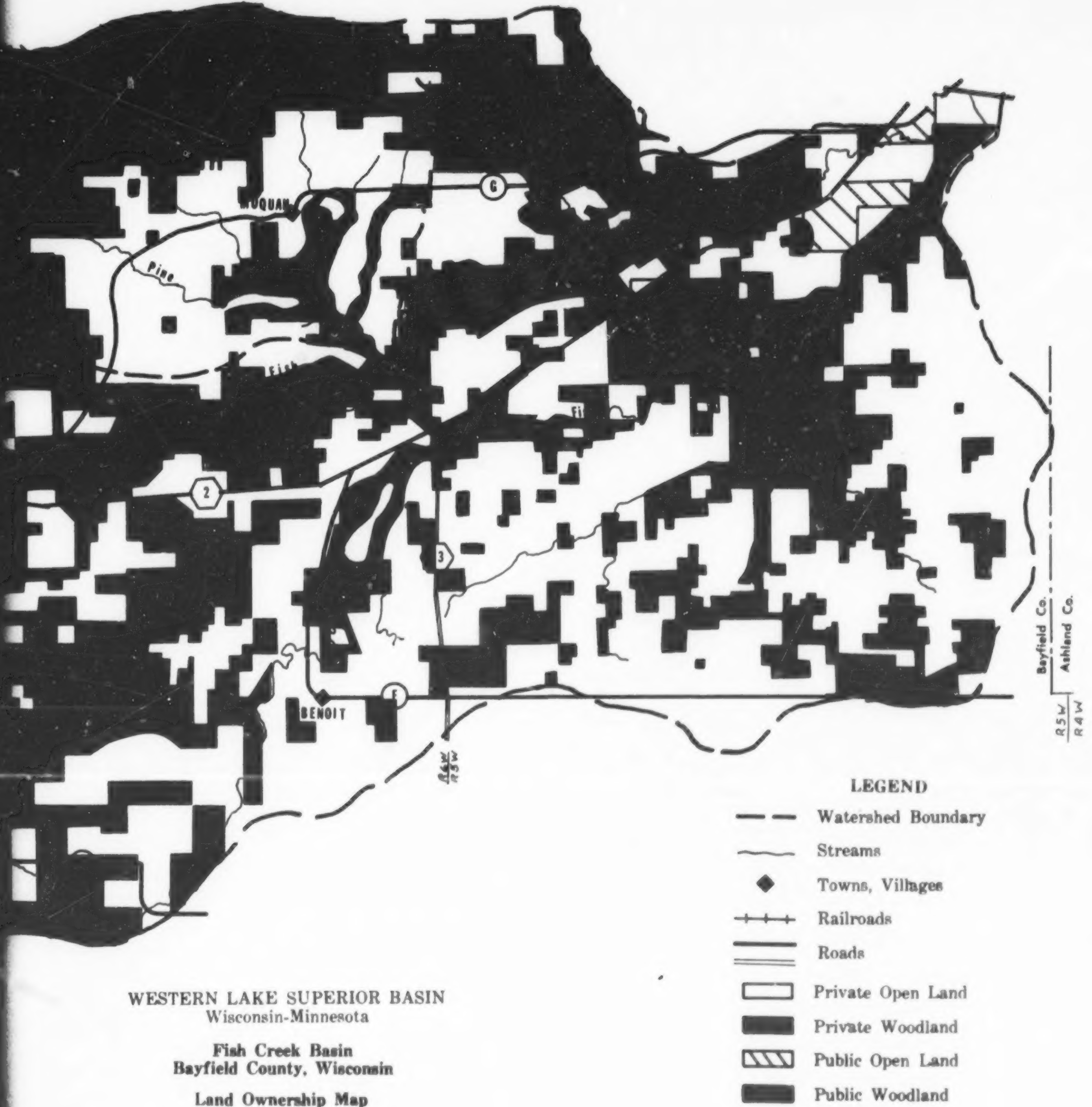
WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Fish Creek Basin
Bayfield County, Wisconsin

Land Ownership Map

Ashland, Bayfield, Carlton, Douglas and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service


MOQUAH
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Pine
Fish
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E
BENOIT
R6W
R5W
Bayfield Co.
Ashland Co.
R5W
R4W
LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads
Private Open Land
Private Woodland
Public Open Land
Public Woodland

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Fish Creek Basin
Bayfield County, Wisconsin

Land Ownership Map

Ashland, Bayfield, Carlton, Douglas and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

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and 7% is other land, such as roads and built up areas.

The Fish Creek basin lies in the Ashland embayment of the Lake Superior lowland. This lowland is the lake plain formed during the high water phase of Glacial Lake Duluth. The red clay which covers the lowland was deposited as sediment in the lake bottom. It is clay with silt and some sand, colored red by stain from iron bearing rock formations. Except in the extreme upper end of the watershed, the surface soils are composed of these lake-laid sediments.

Sandy outwash overlies the clay in the upper parts of the watershed and thick sand and gravel deposits are on the northwest border. Sandy glacial till is on the southwest margin of the watershed. This drift is the remains of the four major advances of the glacier in the area. The till is ground and end moraines with pockets of sand and gravel. The General Soils Map, page 50, shows the general pattern and distribution of soils. More detailed information is contained in Appendix A.

The bedrock underlying Fish Creek Watershed is mainly sandstone and shale of the undifferentiated Upper Keweenawan sedimentary formations of Precambrian age. It is believed that a portion of the Douglas Fault runs east and west through the watershed. There is no evidence of modern movement along this Fault.

Land Capability Units

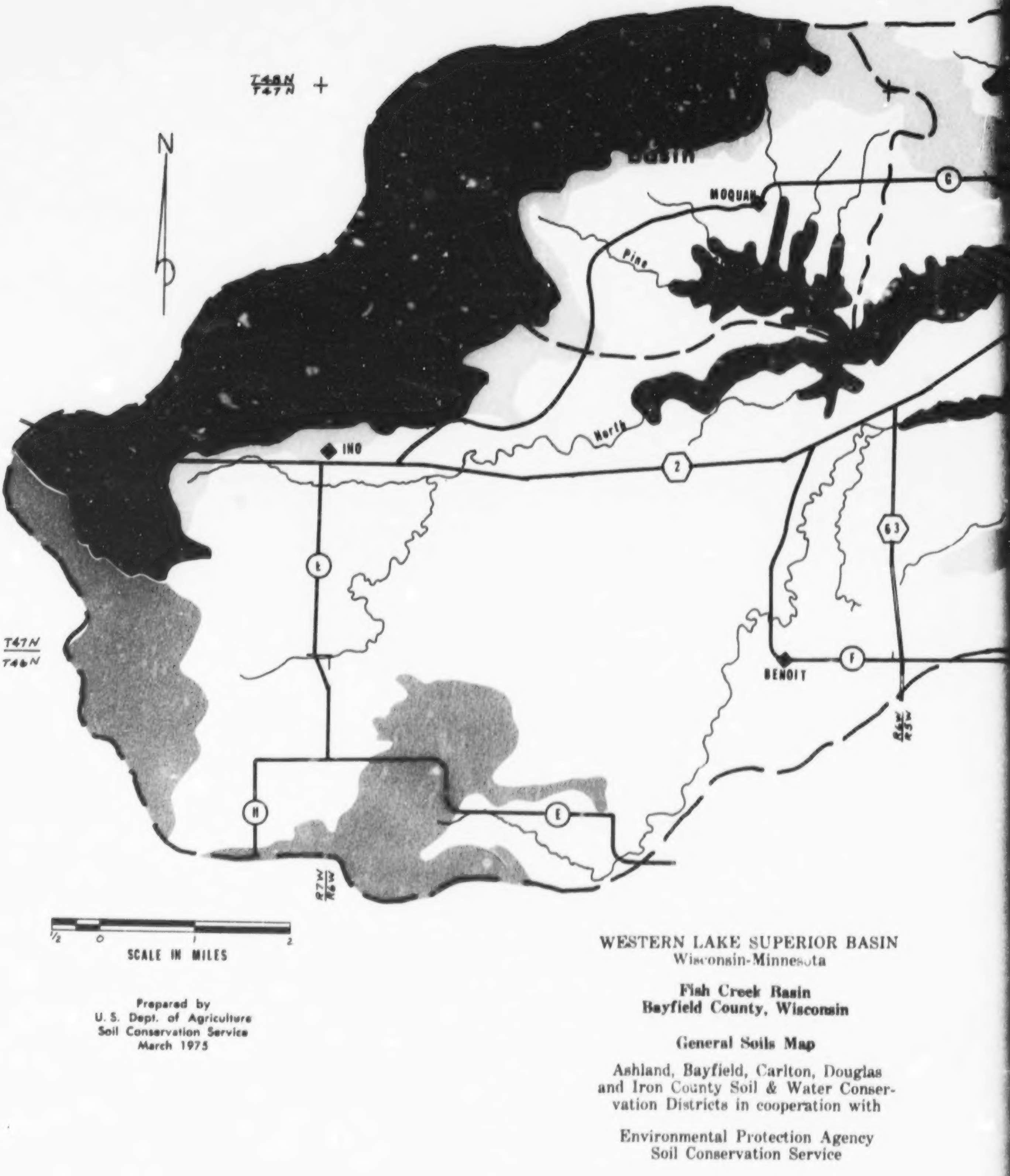
The land capability units represent groupings of soils with common limitations for agricultural uses. The soils in each unit show similar response to like treatment under similar use patterns.

The capability groupings presented here are intended for use in this report only.

There are 38 different kinds of soil in the Fish Creek, Wisconsin study area. This soils make up a total of 20 land capability units which are used in determining land treatment needs. A more detailed description of the soils in each capability unit, their characteristics and limitations is contained in Appendix B. The major soils within each land capability unit are listed in Table 13.

Streambank Erosion

In the Fish Creek watershed the erosion survey was conducted by stereoscopically examining aerial photos of the stream and its tributaries. Two sets of photos were used - dated 1960 and 1970. Field spot checks were made to confirm the evaluations or to correct them where necessary. Table 14 is a summary of the streambank erosion inventory on Fish Creek. The map on page 54, shows the reaches indicated in Table 14.


T48N
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BASIN
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T47N
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BENOIT
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SCALE IN MILES

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

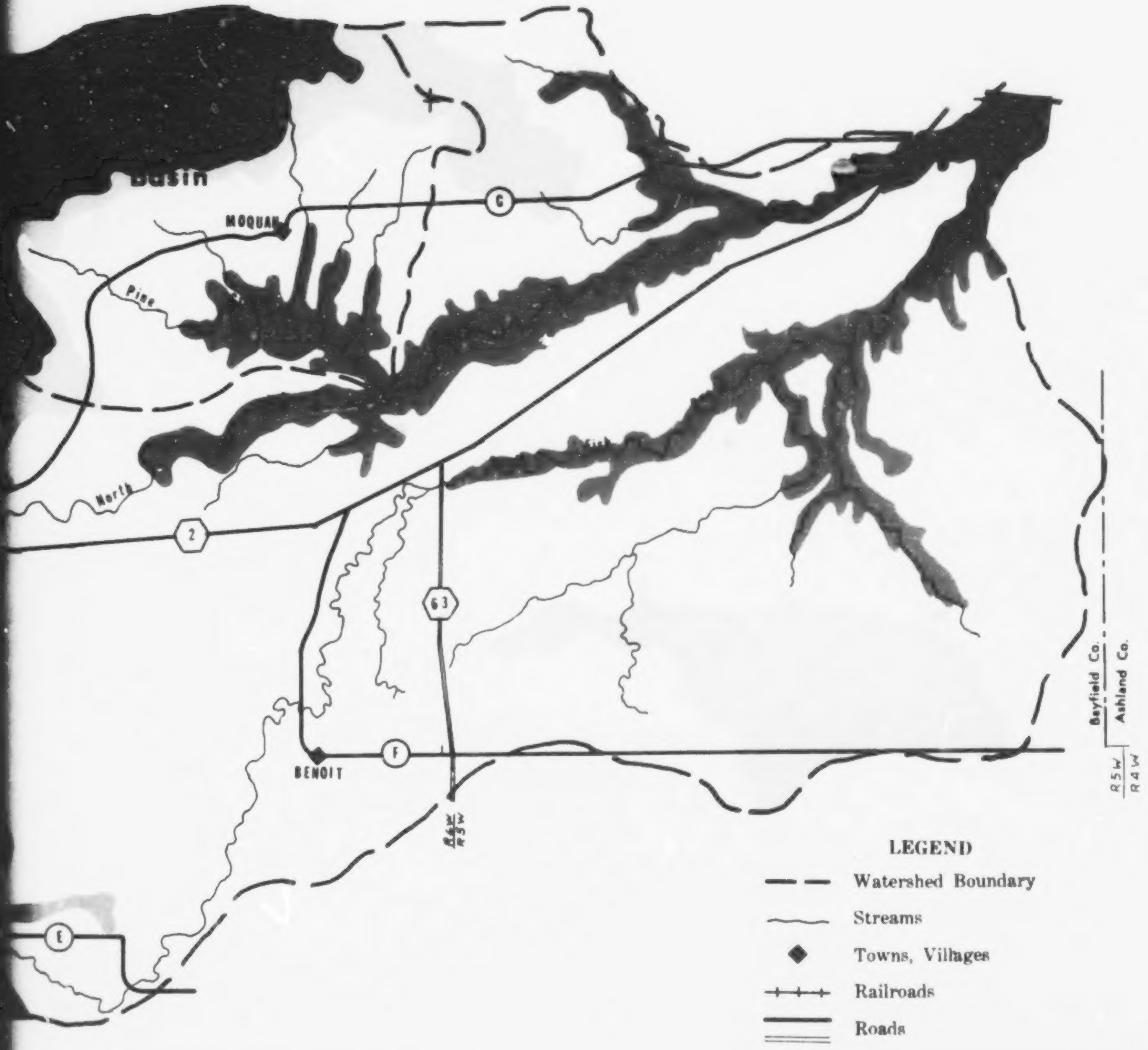
Fish Creek Basin
Bayfield County, Wisconsin

General Soils Map

Ashland, Bayfield, Carlton, Douglas and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975


Basin
MOQUAH
Pine
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Fish
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2
63
F
E
BENOIT
Bayfield Co.
Ashland Co.
R5W
R4W
R6W
R5W

LEGEND

- — — Watershed Boundary
- ～ Streams
- ◆ Towns, Villages
- +++ Railroads
- ═ Roads
- ☐ Ontonagon—Pickford Association
- ☐ Orienta—Superior Association
- ■ Vilas—Omega Association
- ▨ Gogebic—Cloquet Association
- ▨ Steep Clayey Land
- ■ Alluvial Land

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Fish Creek Basin
Bayfield County, Wisconsin

General Soils Map

Ashland, Bayfield, Carlton, Douglas and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

TABLE 13

Soils Data by Capability Unit

	Acreage	Major Soil Series	Major Hazard	Slopes (%)
IIe1	998	Gogebic	Erosion	3-8
IIe2	18,541	Ontonagon	Erosion	3-8
IIe3	2,626	Superior, Ogemaw	Erosion	3-8
IIs1	14,014	Ontonagon	Ponded Water	0-2
IIIe3	1,625	Cloquet, Washburn	Erosion	3-8
IIIw1	1,192	Rudyard, Bergland	Wetness	0-2
IIIw3	242	Allendale, Ogemaw	Wetness	0-2
IVe1	365	Gogebic	Erosion	8-18
IVe2	3,161	Ontonagon	Erosion	8-18
IVs1	1,449	Vilas, Bibon	Drouthiness	0-8
IVw1	25	Rifle	Wetness	0-2
IVw2	45	Newson, Kinross	Wetness	0-2
IVw3	4,554	Orienta	Wetness	0-2
Vw1	1,045	Alluvial Land	Flooding	0-2
VIe1	30	Washburn, Marenisco	Erosion	8-18
VIs1	1,298	Vilas	Drouthiness	3-18
VIIe1	2,513	Steep Clayey Land	Erosion	20-45
VIIs1	5,621	Vilas, Omega	Drouthiness	8-45
VIIw1	197	Greenwood	Wetness	0-2
VIIIw1	184	Marsh	Wetness	0-2

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STREAMBANK EROSION - FISH CREEK
TABLE 14

Reach		Channel Description				Channel Erosion		Slope Failure (Slides)		Other Erosion
No	Straight Line Length (mi)	Length (Mi)	Average Grade (Ft/Mi)	Vertical Depth[1]	Side Slope	No of Sites	Area[2]	No of Slides	Area[2]	
1	1.1	2.2	6.3	2-40[3]	-	4[4]	-	-	-	
2	5.1	7.1	8.4	-	Steep	3	350	4	11,000	900 lin ft along roads & trails 2,300 sq. ft by livestock
3	5.0	5.5	34.	Up to 100	Very Steep	4[5]	3,500[5]	35[5]	131,800[5]	2,500 sq ft gully 1,000 sq ft along private road
4	8.2[6]	10.0	23	-	-	15	2,250	4	3,200	

[1] Depth of channel below plain

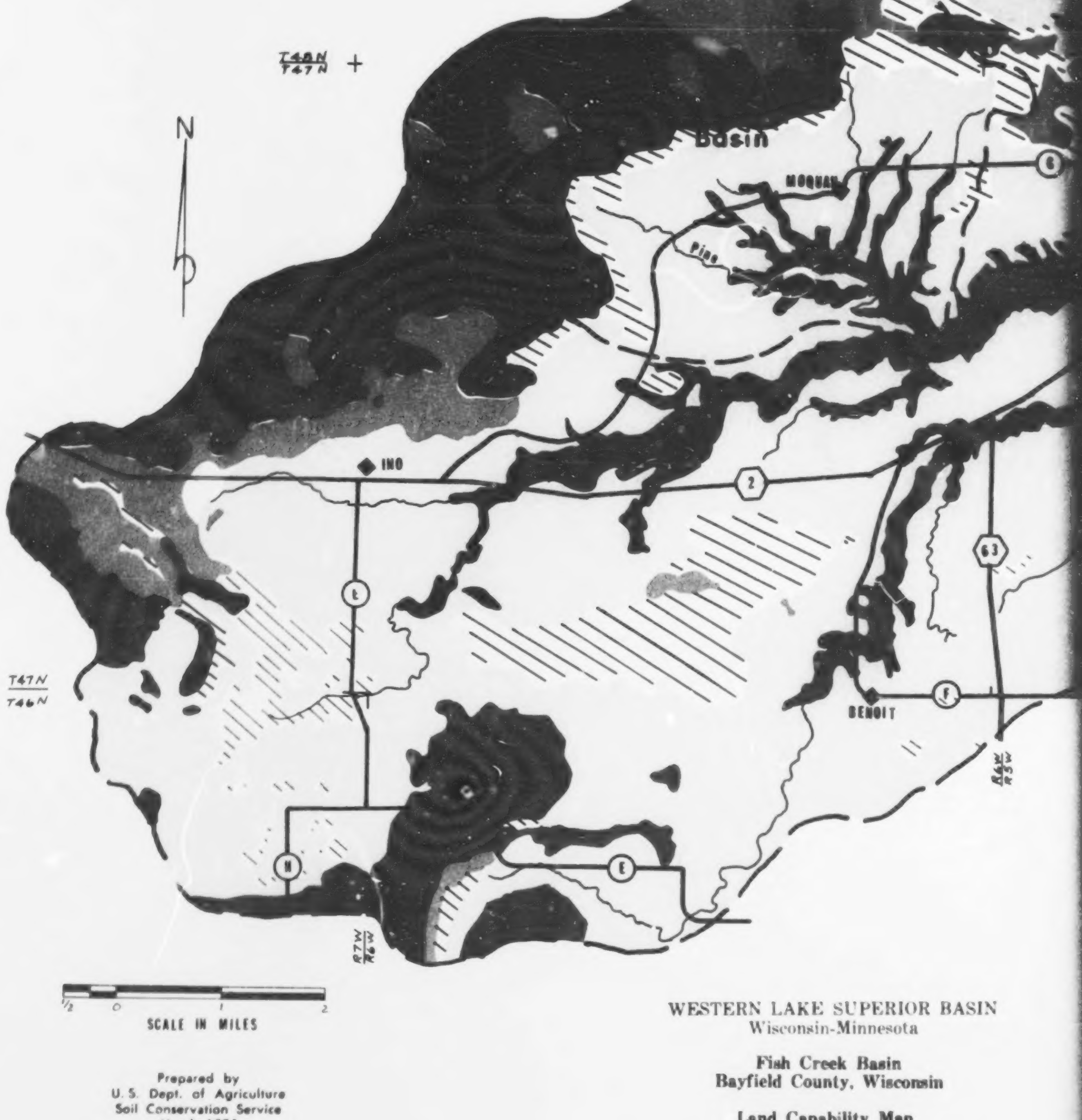
[2] Surface area as determined from aerial photographs

[3] The flood plain is 1,300 to 2,000 feet wide

[4] Erosion consists of lateral cutting of the channel banks

[5] Includes Pine Creek

[6] The creek flows through a broad, low, completely wooded flood plain for 1.2 miles from its junction with the main stream. No erosion is evident in the lower 2.2 miles of the creek.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SCALE IN MILES

Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Fish Creek Basin
Bayfield County, Wisconsin

Land Capability Map

Ashland, Bayfield, Carlton, Douglas and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

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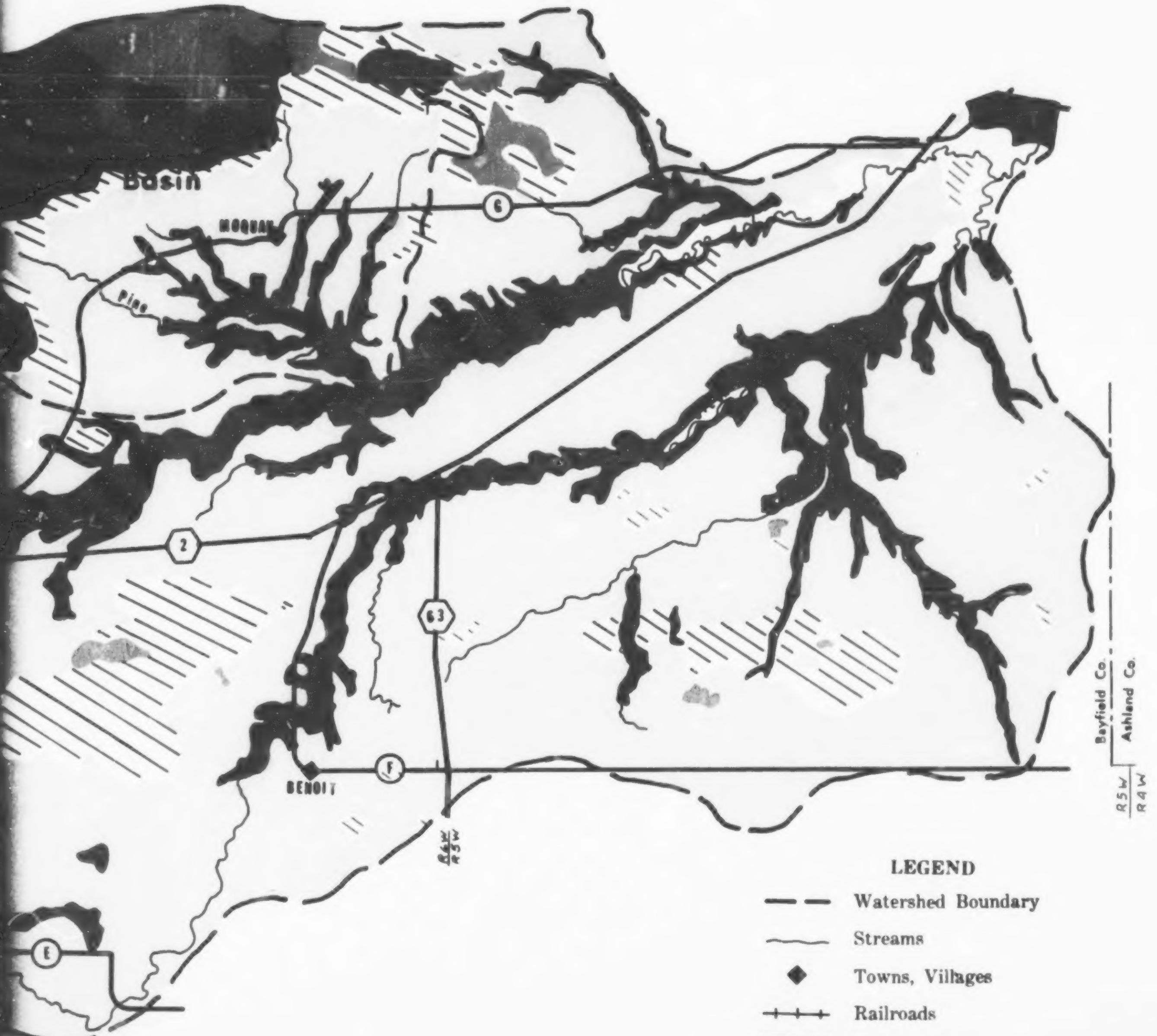
Basin
MOQUAH
Pine
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BENOIT
R6W
R5W
Bayfield Co.
Ashland Co.
R5W
R4W

LEGEND

— — Watershed Boundary

〰 Streams

◆ Towns, Villages

+++ Railroads

═ Roads

☐ Class IIe and IIs

■ Class IIIe

■ Class IVe and IVs

▨ Class IVw

☐ Class Vw

▩ Class VIe and VIs

■ Class VIIe and VIIs

■ Class VIII

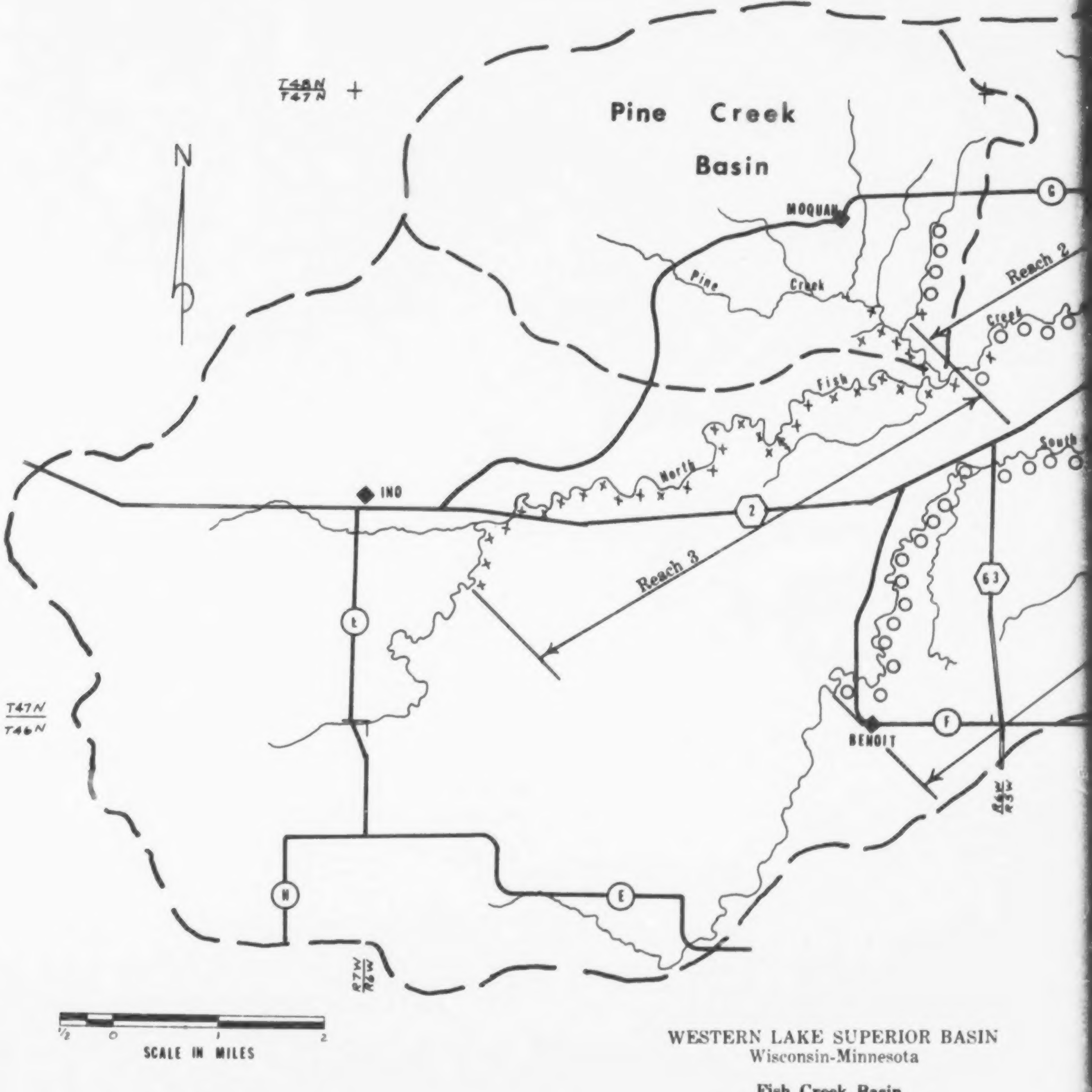
WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Fish Creek Basin
Bayfield County, Wisconsin

Land Capability Map

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conser-
vation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service


T48N
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SCALE IN MILES

Prepared by
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Soil Conservation Service
March 1975

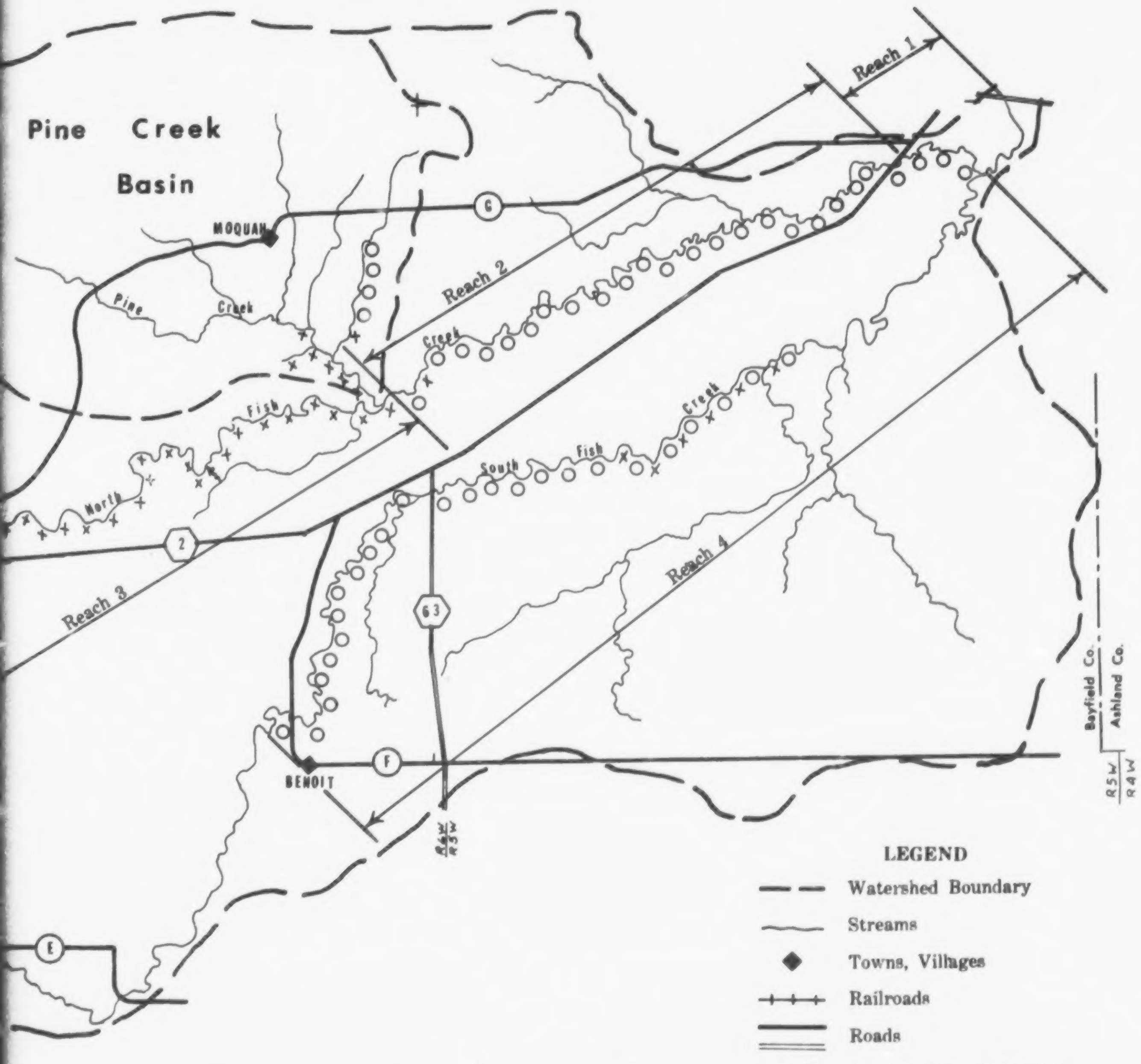
WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Fish Creek Basin
Bayfield County, Wisconsin

Streambank Erosion

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conser-
vation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service


Pine Creek
Basin
MOQUAH
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Pine
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Reach 1
Reach 2
Creek
Fish
North
South
Fish
Creek
Reach 3
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Reach 4
F
BENOIT
E
R6W
R5W
Bayfield Co.
Ashland Co.
R5W
R4W

LEGEND

— —	Watershed Boundary
~	Streams
◆	Towns, Villages
┼┼┼	Railroads
═	Roads
○ ○	Stream Channel Erosion
x x	Bank Erosion (slips, slides)
⤳	Gully

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Fish Creek Basin
Bayfield County, Wisconsin

Streambank Erosion

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conser-
vation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

PINE CREEK WATERSHED STUDY AREA

Selection of Pine Creek Study Area

The Pine Creek Study Area was selected to represent the entire Fish Creek Basin shortly after the initial inventory work was completed. The preliminary studies pointed out that there was not enough money or manpower available to provide land treatment for the entire basin. The alternative was to pick a smaller, yet physically similar watershed within the Fish Creek Basin as a study area. After considering land ownership, soils, type of farm operations and land use the Pine Creek study area was selected to represent the entire Fish Creek Basin.

Description of the Watershed

The Pine Creek watershed is approximately 15.7 square miles in size. It is wedge shaped and 4.5 miles wide and 5 miles long at the extremes. The elevation difference between the top end of the watershed and the junction of Pine Creek and Fish Creek is approximately 600 feet. Aspect is southeasterly.

Pine Creek is an entrenched stream with base flow for the entire year. The storm runoff in the watershed is rapid with the stream carrying a large volume of sediment during the runoff period. The stream gradient ranges from 20 feet/mile near the mouth to 50 feet/mile near the source.

Ontonagon, Ogemaw and Vilas soils predominate in the Pine Creek watershed. Clayey soils make up approximately 60% of the area. The land is divided equally between woodland and openland. Nearly 30 percent of the land is used for active cropland. Dairy and beef farming operations are the primary industries in the watershed.

Land Treatment Needs

An analysis of the study area was made to identify the types and amount of land treatment needs to reduce soil erosion.

This study was completed by Soil Conservation Service personnel based on established procedures.

Table 15 lists the various practices and cost schedule which should be applied in the study area to achieve adequate land treatment and erosion control. It should be pointed out that success of this program will depend on planning with individual landowners and the Sponsors. It is anticipated that treatment of the area will allow an accurate assessment of the effect of the program on water quality.

Table 16 is the schedule for achieving this treatment over a three year period. The practices are briefly described in Appendix C. The amounts listed are in addition to practices currently applied in the study area.

The primary goal of this project is to demonstrate techniques of sediment reduction in the Fish Creek Basin. All work proposed is over and above the "ongoing" District programs presently being carried out in this county.

The Pine Creek study area, which is representative of the Fish Creek Basin, was selected to show the effect of applied land treatment and land use regulation on sediment reduction.

A summary of the proposed Work Plan has been developed to show how the Soil and Water Conservation District plans to accomplish this goal. The Work Plan covers a period of 3 years. Costs and quantities of proposed work and technical assistance are shown in Table 15. A general time schedule is shown in Table 16.

Local Sponsors propose to contract with the Soil Conservation Service for the technical assistance needed to implement the work contained herein. Wherever the Sponsors feel it is to their advantage they will employ technical personnel to assist with implementation.

The S.C.S. will assist the Soil and Water Conservation District in signing up landowners as district cooperators within the study area. This will indicate the extent of local cooperation to be expected and will provide an opportunity to further explain the sediment reduction program. It also provides the means by which the S.C.S. is authorized to provide technical assistance to local landowners within the study area.

A conservation plan will be developed with each cooperator with the assistance of the S.C.S. The conservation plan is a record of the land treatment measures the landowner agrees to apply, the amount of each measure and the projected date of installation. This plan will also serve as the basis for financial cost sharing on the installation of erosion control measures. Installation of selected measures will be carried out by the cooperator with technical assistance from the S.C.S. staff and cost sharing assistance from the S.W.C.D. Landowners that require forestry technical services will be assisted by the Wisconsin Department of Natural Resources. The S.C.S. will assist designated specialists in evaluating the effectiveness of land treatment measures. The Districts will develop a catalog of applicable practices, establish cost share rates and adopt specifications. The financial cost sharing assistance by the District is needed to encourage the installation of practices with individual landowners. Cost share rates will be determined practice by practice by the District. The rate of cost sharing will be from 0% to 100% of total installation cost. An extensive bookkeeping system is needed to administer this portion of the program. It is recommended that the District begin this procedure early in the Phase II operation.

S.W.C.D. work will involve implementation of an upland treatment program. Planning and installation of selected measures will be carried out by the cooperator with technical assistance from the S.C.S. staff. The S.C.S. will assist designated specialists with monitoring the effectiveness of land treatment measures.

Stream channel straightening is proposed for a 200' section near the junction of Pine and Fish Creeks. Landshaping, channel rip-rapping and revegetation will be used for erosion control.

The local unit of government will develop a model land use ordinance. A standard soil survey and resource plan will provide base data for development of the ordinance. The Northwestern Wisconsin Regional Planning and Development Commission will provide technical assistance to develop the ordinance. If the implementation of the ordinance proves effective the ordinance will be expanded for use in the entire Western Lake Superior Basin.

Soil Surveys

Soil surveys will provide basic background data for the planning and implementation of land treatment, land use regulation and structural measures contained herein. In addition, the survey will aid in assessing the magnitude of erosion and treatment needs for the entire project area.

These soil surveys will be completed by a survey team supervised by the S.C.S. Standard soil survey procedures will be followed. Soil-Woodland site index studies will be completed to guide soil interpretation. Soil sampling and analyses will be carried out as needed. A handbook of soil properties and limitations will be developed to assist land uses in each survey area.

Monitoring

1. Water Quality and Streamflow

At the present time there are no monitoring stations in the study area. It is hoped that early installation of the monitoring stations shown on the Work Location map, page 60, will allow us sufficient pretreatment data to judge the effectiveness of the work planned. Two class

"A" stations and one class "B" station will be installed in the Pine Creek Study Area at locations where the most useful data may be generated. The description of these stations and the parameters to be measured are found in Appendix D. In addition to the three USGS stations, grab samples will be taken on an, as yet unspecified, grassed waterway. These samples will be analyzed for nutrient parameters.

2. Precipitation

The study of soil carried by runoff water requires a high density of precipitation measurements with useful resolution of rate over the dynamic range to be encountered. To overcome this problem, a low cost recording intensity of rainfall gauge coupled with a digital memory system will be installed on a one per square mile basis (12). In addition three wedge-type, total rainfall gauges will be placed in the basin for a comparison with measurement made with other gauges.

3. Soil and Air Temperature

The temperature of the soil at several depths and air temperatures will be measured with silicon type sensors. Three temperature recorders will be placed in the study area.

LAND TREATMENT GOALS & ESTIMATED INSTALLATION COSTS

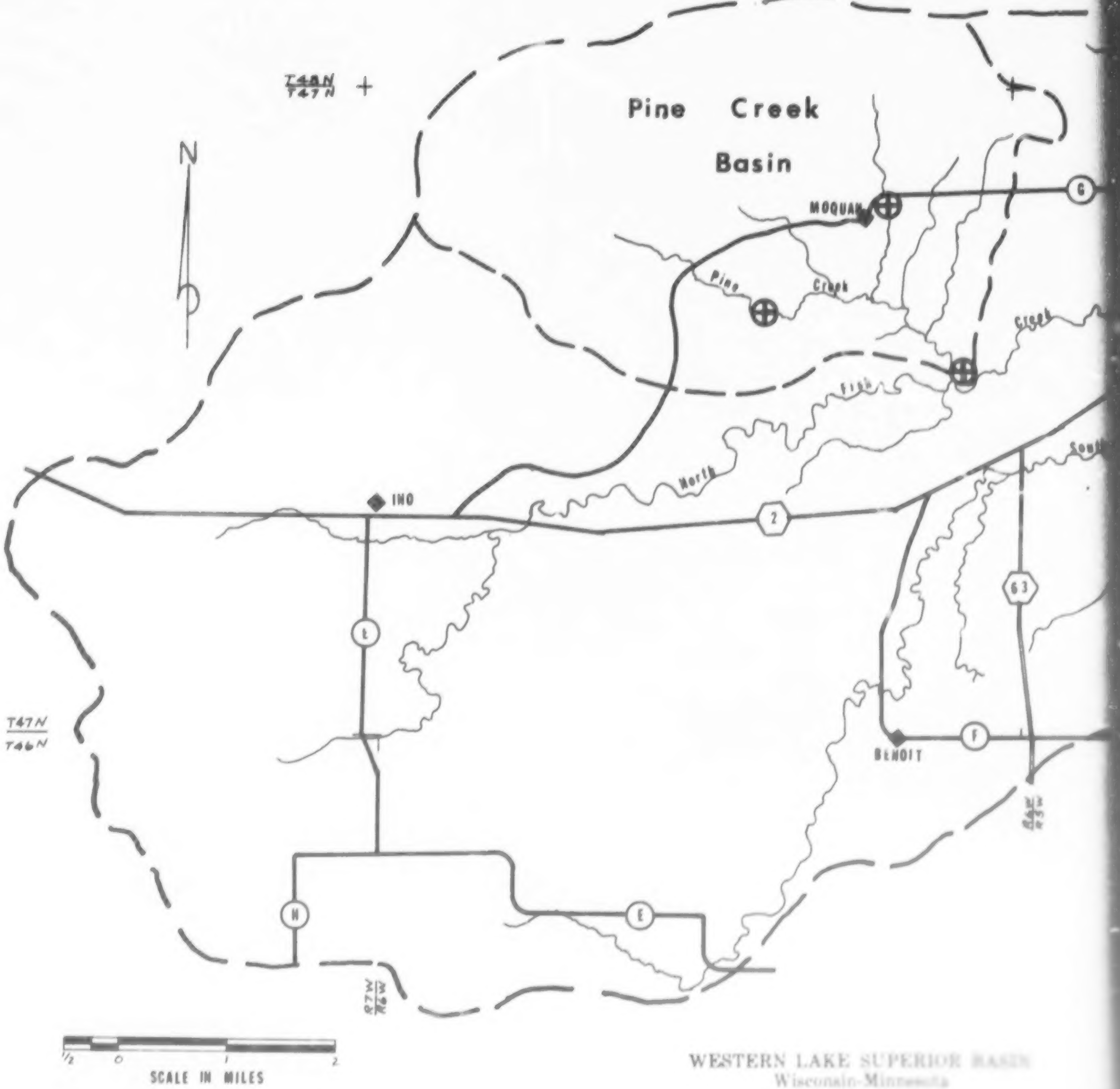
Pine Creek Study Area

Item	Unit	Unit Cost	Tech. Assist/ Unit (MD)	Total Needs	To Be Treated With Ongoing Program	Accelerated EPA Treatment	Accelerated Costs Installation	Accelerated Costs Technical Assist
A. Management								
Conservation Plan Revision	No.	-	3	8	1	7	-	1,300
Conservation Plan Revision	Ac.	-	-	1,000	100	900	-	-
Conservation Plans	No.	-	5	28	2	26	-	8,200
Conservation Plans	Ac.	-	-	3,800	360	3,440	-	-
District Cooperators	No.	-	0.1	28	4	24	-	150
District Cooperators	Ac.	-	-	3,800	500	3,300	-	-
Land Adequately Treated	Ac.	-	-	3,200	100	3,100	-	-
Livestock Exclusion	Ac.	-	-	120	-	120	-	-
Woodland Improvement	Ac.	-	0.01	400	-	400	-	250
Woodland Site Preparation	Ac.	-	0.01	5	-	5	-	50
B. Land Treatment								
Animal Waste Systems	No.	15,000.00	12.5	4	0	4	21,030	2,045
Brush Management	Ac.	4.00	-	50	-	50	$ 200	-
Conservation Cropping Systems	Ac.	2.00	-	820	20	800	1,600	-
Critical Area Planting	Ac.	600.00	1.5	3	-	3	-	300
Crop Residue Management	Ac.	1.50	0.05	35	5	30	45	100

TABLE 15

Item	Unit	Unit Cost	Tech. Assist/ Unit (MD)	Total Needs	To Be Treated With Ongoing Program	Accelerated EPA Treatment	Accelerated Costs Installation	Accelerated Costs Technical Assist
Diversion	Ft.	.75	0.002	4,000	300	3,700	2,775	500
Drainage Field Ditch	Ft.	.40	0.0008	36,960	6,960	30,600	12,000	1,500
Fencing	Ft.	.70	0.0002	40,000	-	40,000	30,000	500
Grassed Waterways	Ac.	500.00	1.0	97	3	94	37,600	4,680
Landsmoothing	Ac.	25.00	0.03	950	310	640	16,000	1,200
Pasture & Hayland Management	Ac.	20.00	0.06	300	20	280	5,600	1,050
Pasture & Hayland Planting	Ac.	80.00	0.06	130	10	120	9,600	450
Stock Trail & Walkway (Water Facility)	Ft.	23.00	0.01	1,000	0	1,000	23,000	650
Subsurface Drains	Ft.	1.00	0.001	250	0	250	250	50
Tree Planting	Ac.	100.00	0.02	44	14	20	2,000	25
C. Stream Channel Protection	Ft.	40.00	.18	200	-	200	8,000	2,700
TOTAL							$169,700	$25,700

TABLE 15 (Continued)


T48N
T47N
Pine Creek Basin
N
MOQUAH
G
Pine
Creek
Creek
Fish
North
South
INO
2
63
L
T47N
T46N
BENOIT
F
R6W
R5W
H
E
R7W
R6W
1/2
0
1
2
SCALE IN MILES

Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975

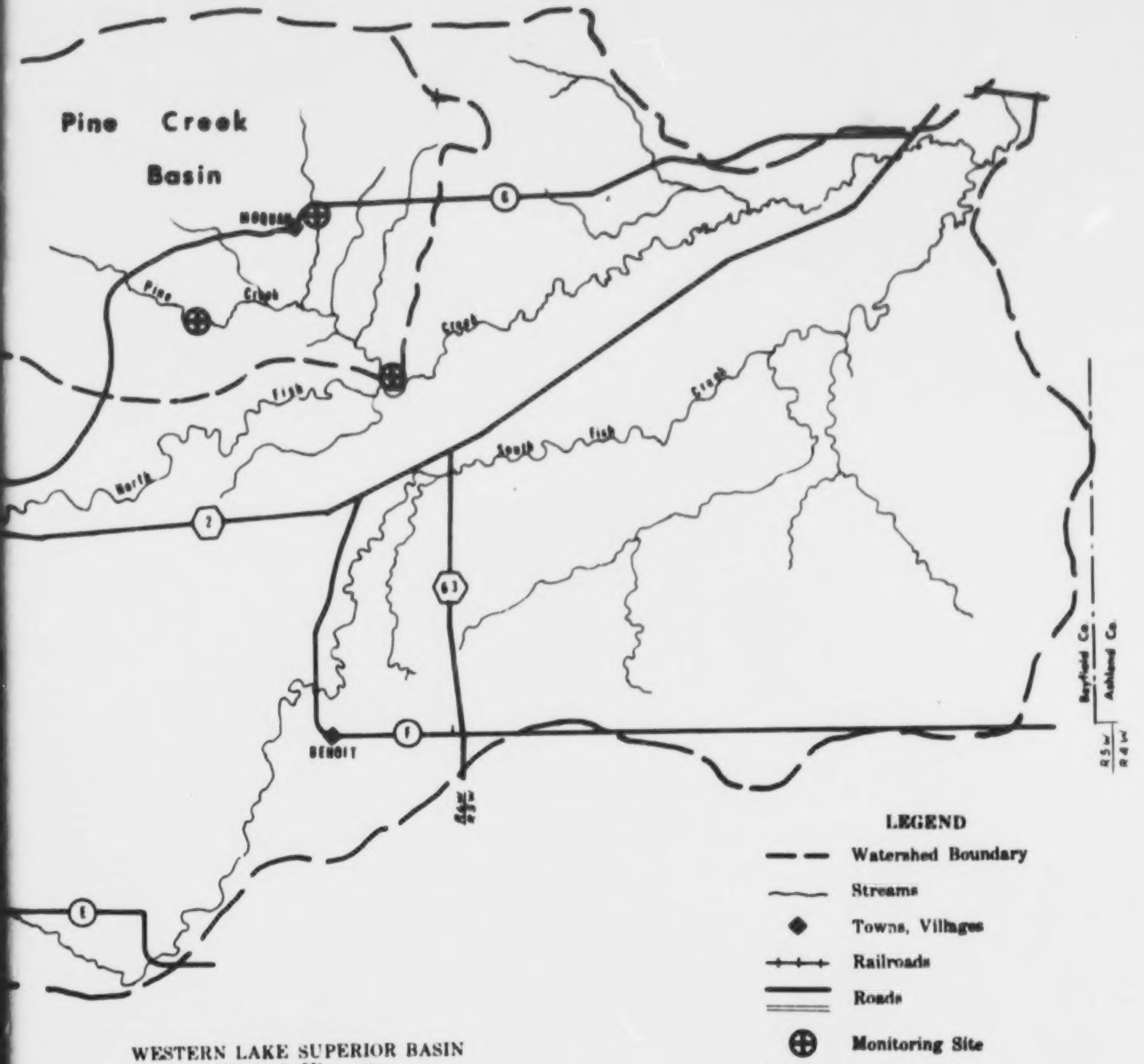
WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Fish Creek Basin
Bayfield County, Wisconsin

Monitoring Location Map

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conser-
vation Districts in cooperation with:

Environmental Protection Agency
Soil Conservation Service


Pine Creek Basin
MOQUAH
Pine Creek
Fish Creek
North Fish Creek
South Fish Creek
6
2
63
F
E
BENOIT
Bayfield Co.
Ashland Co.
R5W
R4W
LEGEND
Watershed Boundary
Streams
Towns, Villages
Railroads
Roads
Monitoring Site

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Fish Creek Basin
Bayfield County, Wisconsin

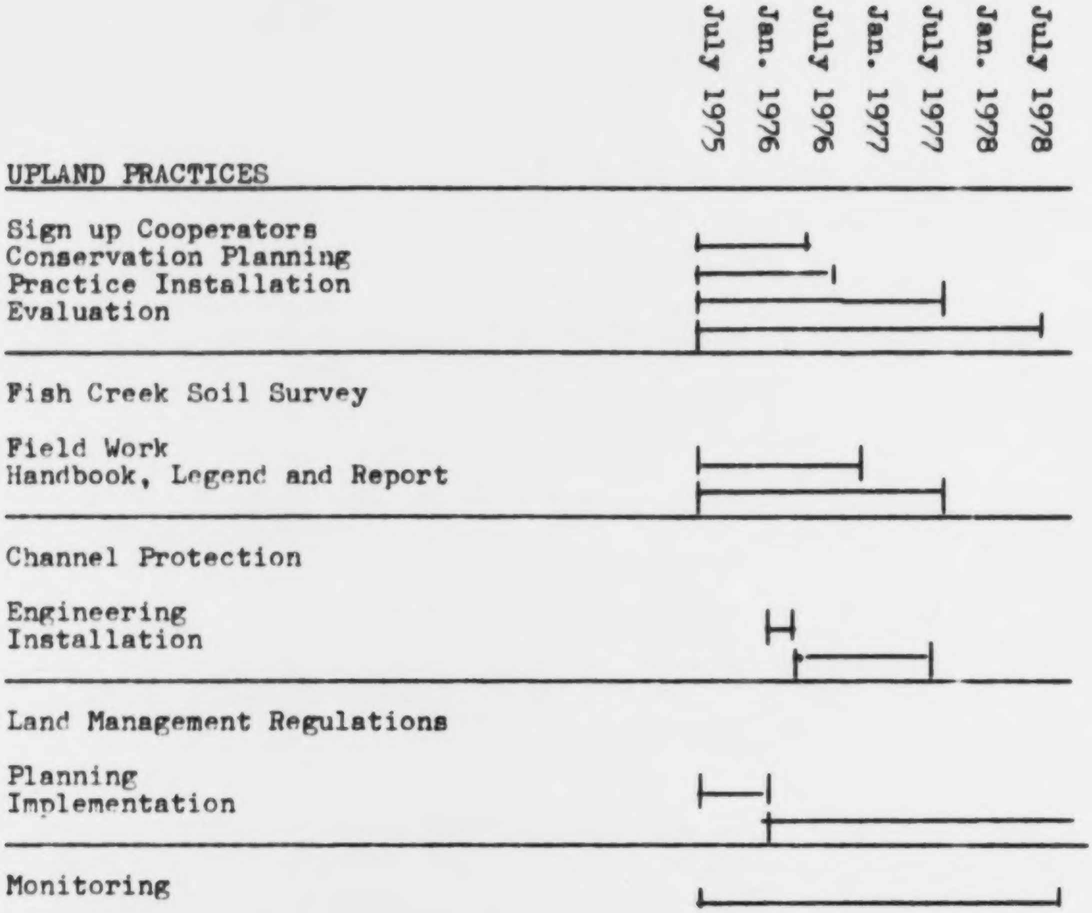
Monitoring Location Map

Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conser-
vation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service

TABLE 16 WORK PLAN
TIME SCHEDULE

Pine Creek Basin



ORONTO/PARKER CREEK BASIN

Description

The Oronto/Parker Creek Basin is on the south shore of Lake Superior in Iron County, Wisconsin. Oronto Creek and Parker Creek flow together for about 300 feet before entering Lake Superior at Saxon Harbor. The floodplain, about 15 acres in area, has been improved to include a picnic area, marina and flood channel. Spoon Creek flows into Oronto Creek from the south approximately one stream mile above Saxon Harbor.

The watershed size is 18.0 square miles of which 12.4 square miles is in Parker Creek. The watershed is wedge shaped and approximately 4 miles long and 6 miles at the extremes. The elevation difference from the top of the watershed to Lake Superior is about 500 feet. The drainage pattern is modified dendritic with numerous tributaries that nearly parallel the main stream.

A base flow is present most of the year. Storm runoff is rapid and short duration. The average gradient is about 50 feet per mile on Oronto Creek and about 40 feet per mile on Parker Creek. The streams carry a large volume of sediment during storm runoff. Much of the lower segment of the streams flow over bedrock.

Little modern soil survey data are available in the watershed. Preliminary investigation indicates that most of the watershed is an association of Hibbing, Pickford and Ontonagon soils with some sandstone bedrock outcrops along the stream channels. Most of the watershed is forested and access is limited to primitive means.

SPOON CREEK STUDY AREA

The Spoon Creek study area was selected to represent the conditions in the Oronto/Parker Creek Basin. Spoon Creek is not classified as a trout stream. Local citizens refer to it as a moderate sediment producer.

Description

The watershed is 3 square miles in size. It is wedge shaped and approximately 3 miles long and 1.5 miles wide at the extremes. The elevation difference from the top of the watershed to the structure site is approximately 300 feet. The drainage pattern is modified dendritic with an unnamed tributary that parallels the main stream channel.

The soils are mainly clayey Hibbing, Pickford and Ontonagon soils. Land use in the study area is primarily deciduous, second growth forest with open grassland that is reverting to brush and forest. Land use intensity is low. Access to the study area is good.

Demonstration

Trapping of sediment will be demonstrated by construction of a single purpose debris basin in the Spoon Creek study area. The efficiency of the sediment trap and the type of sediment removed are unknown at this time. The debris basin will have a 25 to 50 year design life.

The debris basin will be constructed immediately below the confluence of Spoon Creek and an unnamed tributary. This will consist of a 25 acre pond that will hold the estimated sedimentation. The structure will be a full flow outlet structure.

Soil and Water Conservation District work will include:
1) Detailed site investigations including assessments of soils, geology and foundation materials. 2) Field engineering surveys to determine precise site location and provide additional structure design data. 3) Inspection of construction of debris basin. 4) Monitoring with effectiveness of the sediment basin by the Soil Conservation Service, United States Geological Survey and others.

Soil Survey

A soil survey will be completed on 8,820 acres. This soil information will provide basic resource data for evaluation and construction purposes.

Monitoring

1. Water Quality and Streamflow

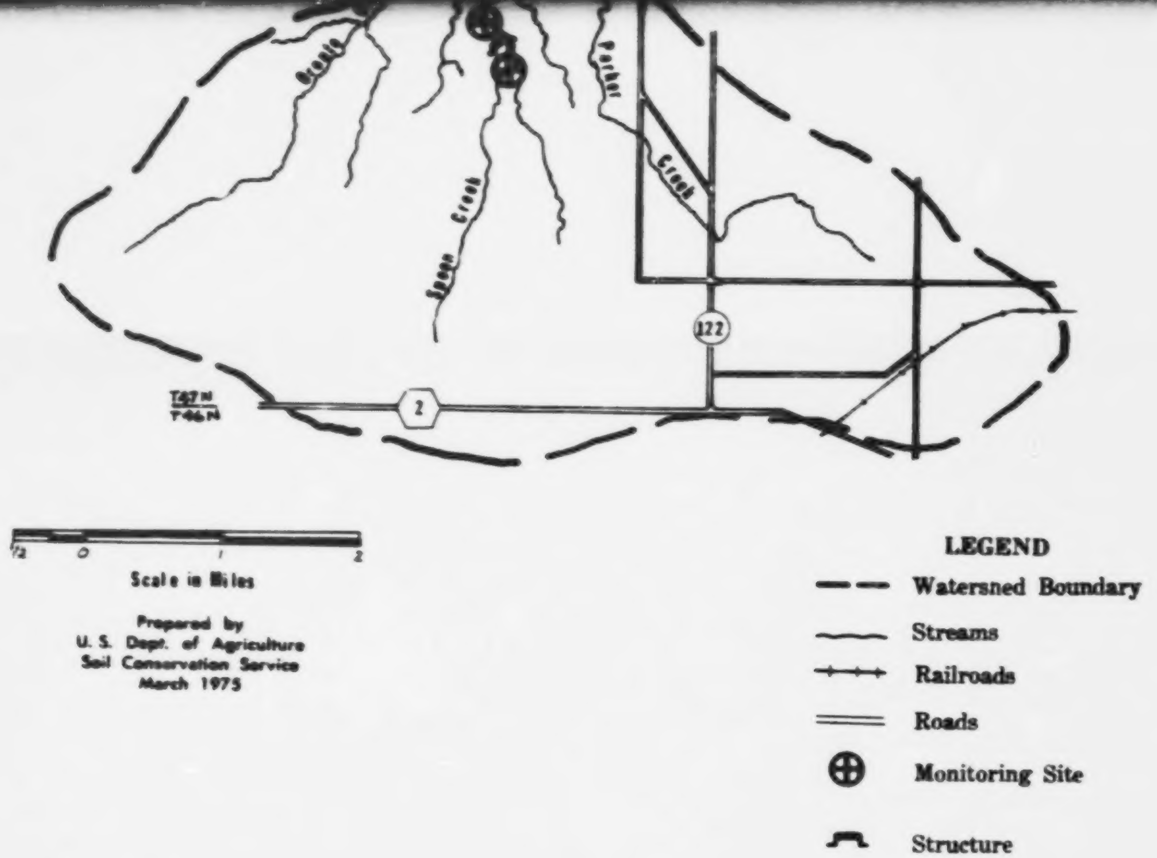
At the present time there are no monitoring stations in the study area. It is hoped that early installation of the monitoring stations shown on the Work Location map, page 65, will allow us sufficient pretreatment data to judge the effectiveness of the work planned. One class "A" station and one class "B" station will be installed in the Spoon Creek Study Area at locations where the most useful data may be generated. The description of these stations and the parameters to be measured are found in Appendix D.

2. Precipitation

The study of soil carried by runoff water requires a high density of precipitation measurements with useful resolution of rate over the dynamic range to be encountered. To overcome this problem, a low cost recording intensity of rainfall gauge coupled with a digital memory system will be installed on a one per square mile basis (12). In addition three wedge-type, total rainfall gauges will be placed in the basin for a comparison with measurement made with other gauges.

3. Soil and Air Temperature

The temperature of the soil at several depths and air temperatures will be measured with silicon type sensors. Three temperature recorders will be placed in the study area.


Orento
Spoon Creek
Parker
Creek
2
122
T47N
T46N
½ 0 1 2
Scale in Miles
LEGEND
Watersned Boundary
Streams
Railroads
Roads
Monitoring Site
Structure

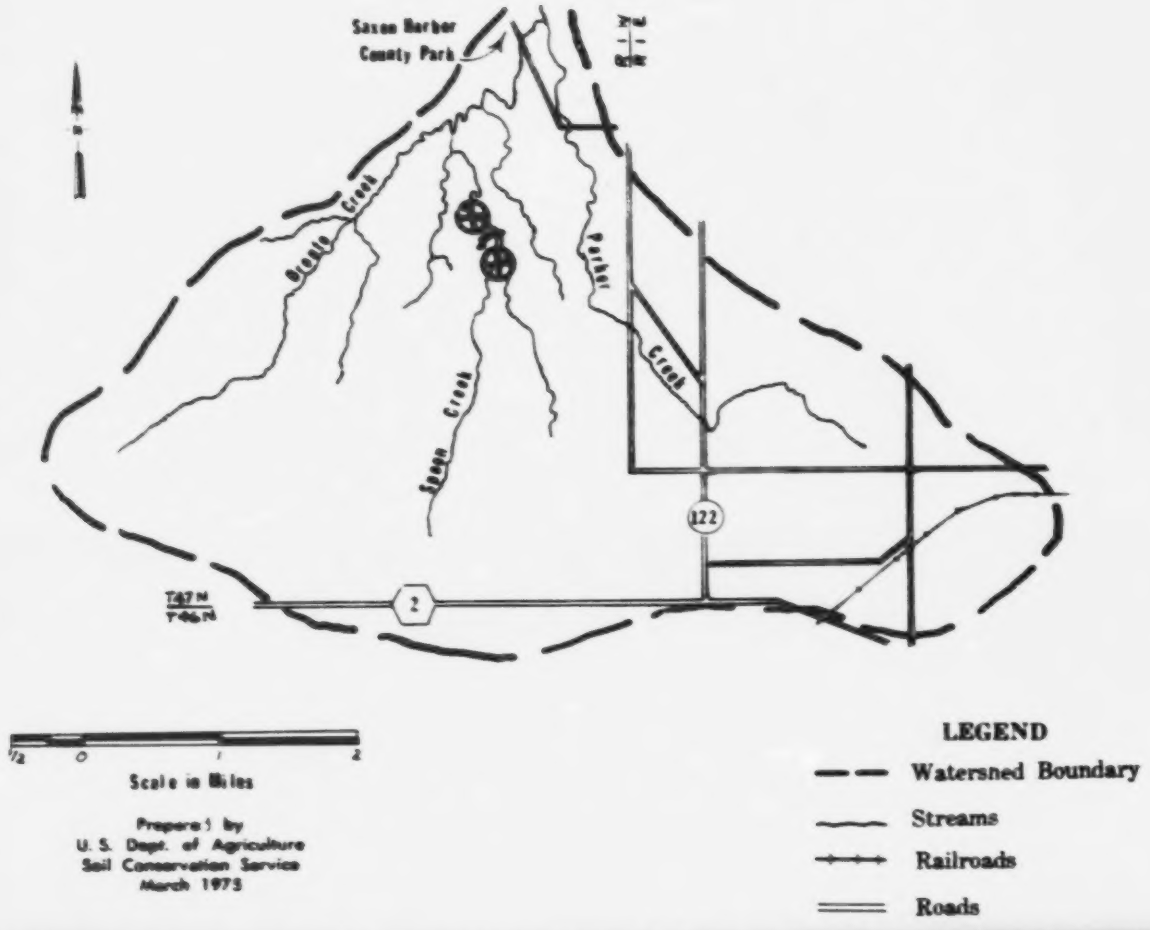
Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975

WESTERN LAKE SUPERIOR BASIN
Wisconsin-Minnesota

Orento—Parker Creek Basin
Iron County, Wisconsin

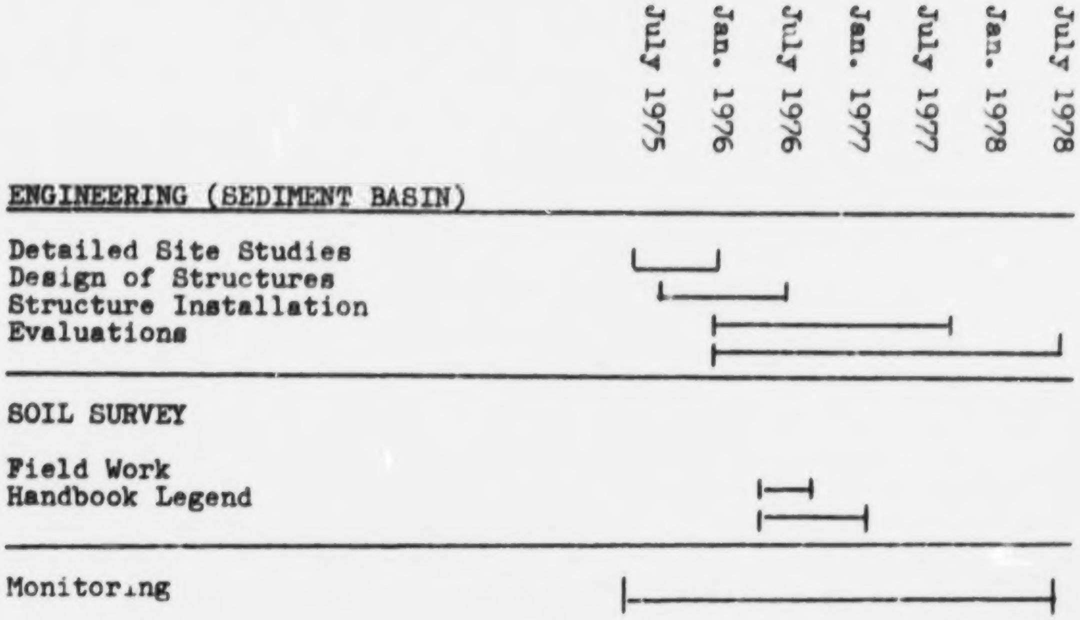
Work and Monitoring Location Map
Ashland, Bayfield, Carlton, Douglas
and Iron County Soil & Water Conservation Districts in cooperation with

Environmental Protection Agency
Soil Conservation Service


Saxon Harbor
County Park
Oronto Creek
Spoon Creek
Parker Creek
T47N
T46N
2
122
½
0
1
2
Scale in Miles
LEGEND
Watersned Boundary
Streams
Railroads
Roads

Prepared by
U. S. Dept. of Agriculture
Soil Conservation Service
March 1975

TABLE 17
ORONTO/PARKER CREEK
TIME SCHEDULE



VI. ASHLAND SHORELINE STUDY AREA

Description

The lake chart given in figure 1 on page 68 outlines the area of interest for this investigation. The Red Clay Soil Belt within Wisconsin Lake Superior Drainage Basin is also given in figure 1 as an inset. The physical description of the shoreline along Ashland County mainland is indicated in the same figure. East of Chequamegon Point, from the Michigan-Wisconsin boundary to the Waverly Campground in Ashland County, the shoreline consists of erodible high bluffs (30 ft. or higher) which drop to erodible low bluffs and to the west of the City of Ashland, some artifical fill area. Madeline Island shoreline is variable from non-erodible bluffs (brown stone) to erodible low bluffs (red clay) to erodible low plains and beaches.

The portion of the Ashland County mainland shoreline from Iron County in the east to a few miles east of the City of Ashland in the west, belongs to Bad River Indian Reservation. With the exception of a small portion around the Lake Park in the City of Ashland, the remainder is mostly private lands.

Selection of Potential Study Areas

For the purpose of the initial survey, four sites were chosen on the basis of the following criteria:

a) problem areas or regions of an immediate and serious nature as identified by reports of local county agents and other sources;

b) sites that are readily accessible from main thoroughfares;

c) sites located on non-private, riparian property.

The locations of the four sites, so chosen, are shown in figure 1 and listed below:

Site 1 - Madigan Beach, a high 'red clay' bluff area located along the Lake Superior shoreline about 1-1/4 miles west of the Iron County line in the Bad River Indian Reservation.

This site is accessed by a 2-1/2 mile secondary (dirt) road directed northeastward off U.S. State Highway 2. It is located 2,000 ft. west of the mouth of Morrison Creek. Measurements and samples were taken principally at a 60-foot high bluff located at the lakeward terminus of the access road (figure 2) page 69. The surface of the upland region immediately back of the bluff crest

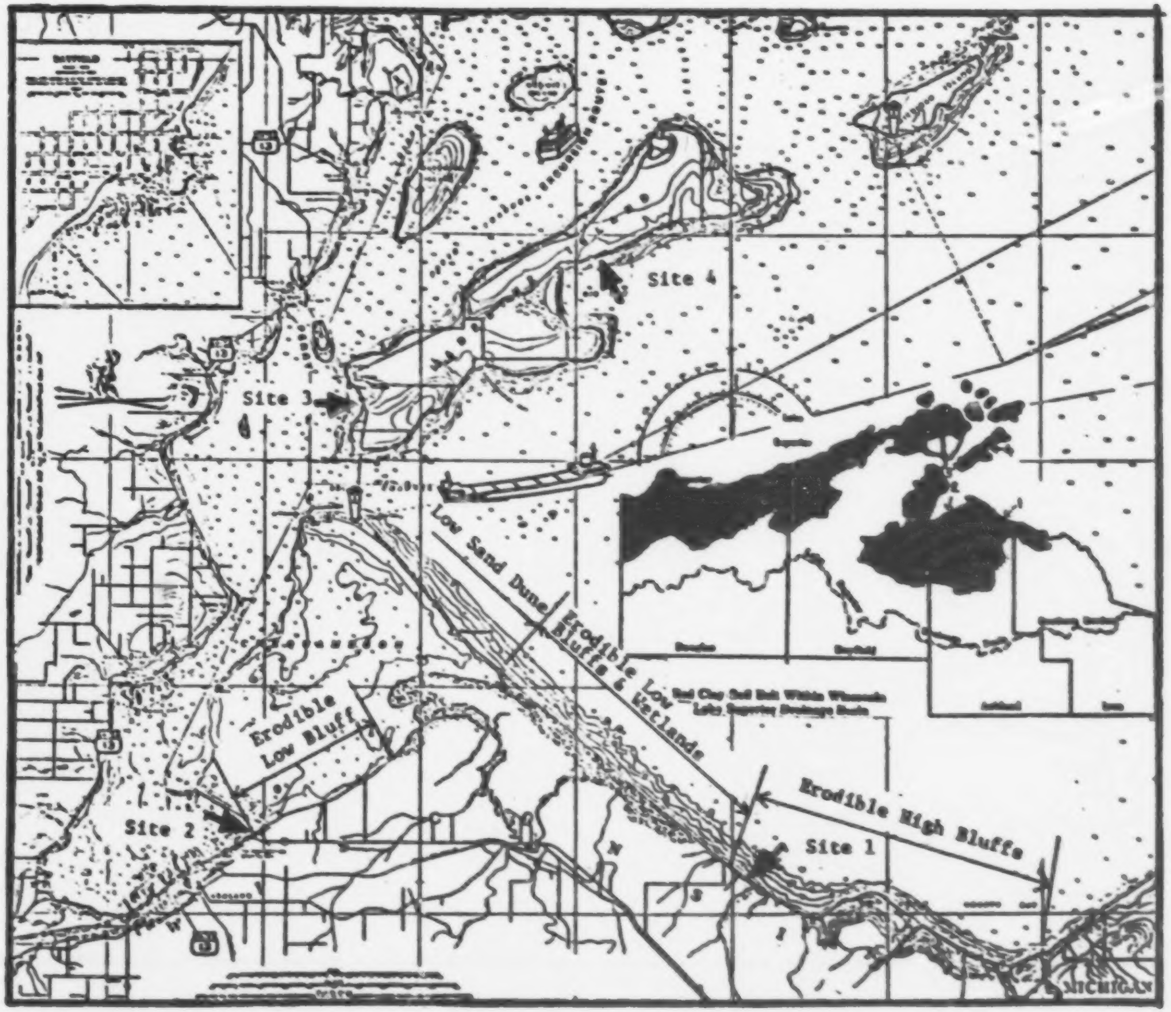
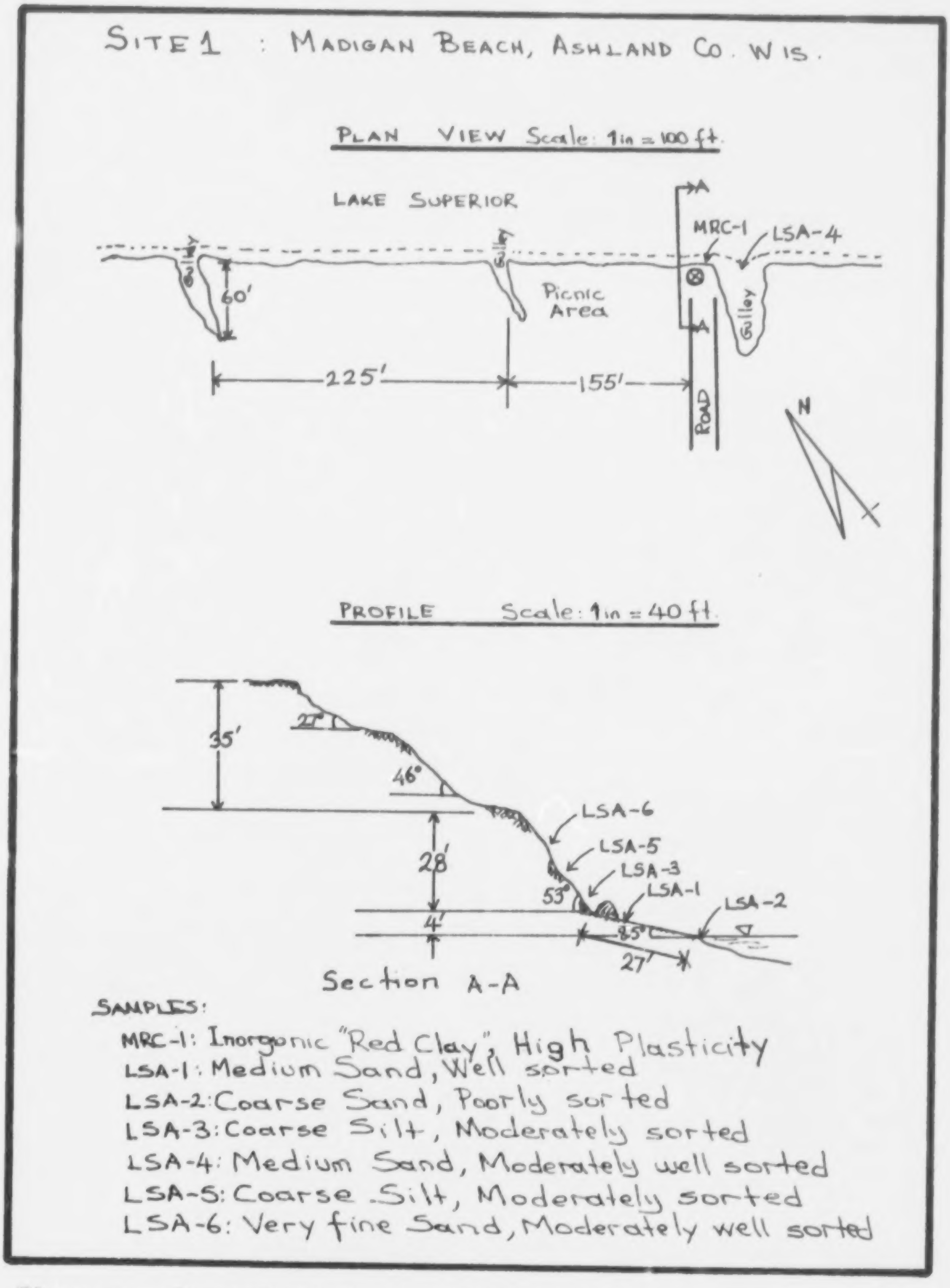

Site 4
Site 3
Low Sand Dune
Erodible Low Bluffs & Wetlands
Erodible Low Bluff
Site 2
Erodible High Bluffs
Site 1
MICHIGAN

Figure 1 Location Map of the Sites


SITE 1 : MADIGAN BEACH, ASHLAND CO. WIS.
PLAN VIEW Scale: 1in = 100 ft.
LAKE SUPERIOR
Gulley
Gulley
60'
Picnic Area
MRC-1
LSA-4
A
A
Gulley
225'
155'
ROAD
N
PROFILE Scale: 1in = 40 ft.
35'
27°
46°
28'
53°
4'
85°
27'
LSA-6
LSA-5
LSA-3
LSA-1
LSA-2
Section A-A

SAMPLES:

MRC-1: Inorganic "Red Clay", High Plasticity
LSA-1: Medium Sand, Well sorted
LSA-2: Coarse Sand, Poorly sorted
LSA-3: Coarse Silt, Moderately sorted
LSA-4: Medium Sand, Moderately well sorted
LSA-5: Coarse Silt, Moderately sorted
LSA-6: Very fine Sand, Moderately well sorted

Figure 2 Geometrical Characteristics of Site 1

is a smooth, grassy and wooded plain overgrown by a young stand of birches, poplar and some evergreens. Removal of the woody vegetation from the creek banks just east of the road terminus has resulted in considerable bank erosion by gullying and quarrying.

The shoreline profile (figure 2) page 69 shows that the bluff face at this site has been terraced at several elevations en echelon by rotational slumping. In general, the several terrace blocks have retained remarkably steep lakeward facing slopes ranging from a uniform 53° in the lower 28-foot section to a discontinuous series of slump blocks having slopes ranging from 46° to 27° near the bluff crest. Individually, these slopes generally exceed the normal angles of repose of loose, unconsolidated sediments such as clean sand which tends to develop natural sloping surfaces with angles ranging from 34° to 37° (Strahler, 1971, p. 583).

The Madigan Beach site is representative of a long, distinctive reach of shoreline undergoing critical erosion. Approximate computations of volumetric changes in shoreline materials based on measured recession rates and bluff profiles indicate that some 2.3 cubic yards of sediment per linear foot of shoreline per year are contributed to Lake Superior at this site (Table 5). While this volumetric rate is slightly less than the rate observed at the Lake Park site (2.7 cu. yd/ft/yr), the much greater shoreline length involved at Madigan Beach must be noted. If the above rate of sediment displacement is assumed to be an average value for the critical 12-mile segment of high, 'red clay' bluff reach, the overall annual contribution of sediment to the lake is approximately 150,000 cu. yd/yr (115,000 cu. meters/yr).

In addition to the length of the shoreline segment, the height of the bluffs and the nature of the materials involved are important factors which make this segment of the Lake Superior shoreline a very significant site for further study. This site would offer an appropriate and suitable location for the shore protection demonstration project. A major benefit which can be drawn from a demonstration at this site is the experience gained in searching for a suitable and feasible protection for such an environment. This may be very significant if a major project is to be undertaken in the future to protect this shoreline.

Site 2 - Lake Park, located on the shoreline of Chequamegon Bay about 1-1/2 miles east of the eastern limits of the City of Ashland.

This site comprises a recreational development about 600 feet along the eastern shore of Chequamegon Bay. A portion of the embankment was cut back to a mean slope of about 30° and stabilized with grass sod. Stone rubble was used to protect some portions of the shore from the undermining action of waves. A small pier juts directly out into the bay for about 75 feet. At the eastern and western extremities of the protected areas, severe erosion and bank recession have taken place (figure 3). At the unprotected western end of the park, moderate rotational slumping has occurred along some 200 feet of the shoreline.

This part of the site dramatically illustrates the limited effectiveness of discontinuous shoreline remedial structures.

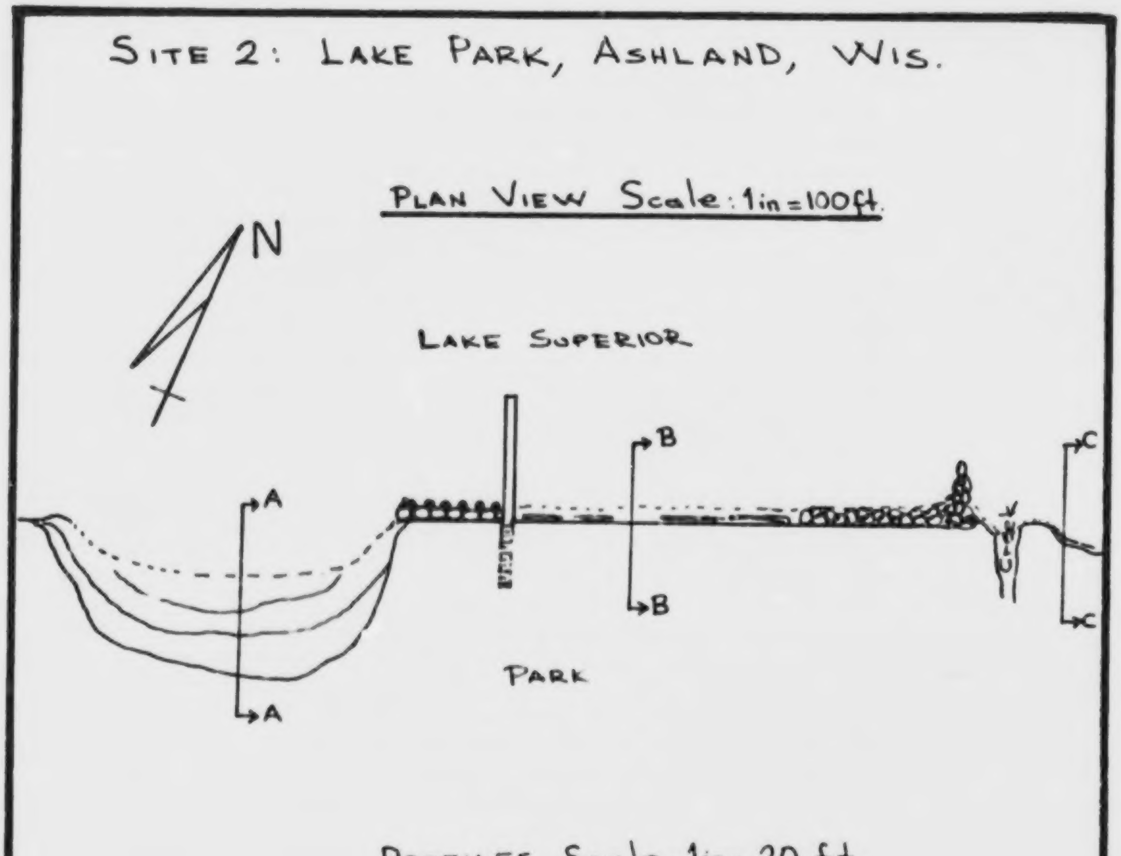
At the eastern end of the park a small creek discharges into the bay and dissects a 27-foot, very steep bluff of highly erodible silty to fine sandy 'red' clay with low plasticity. This sample differs markedly from the 'red clay' encountered at the Madigan Beach site.

The rotational slump of the western end and the near vertical bluff of the eastern end at this site serve as an excellent example of superposed effects of erosion and land sliding on bluff recession and loss of property.

While wave action is the principal mechanism by which the shoreline is being undermined in the vicinity of the park, littoral drift serves to transport the eroded sediments northeastward along the shore. Ragotzkie, et al. (1969) have identified the near surface current regime generated in this area by 8-knot winds from the southwest. A strong easterly-directed component of this current had speeds on the order of 20 cm/sec. (0.39 kt), a velocity which is sufficient to transport medium to coarse sand (0.25 to 1.0 mm) (Sundborg, 1956).

The pier which juts into the lake interrupts to a limited extent the longshore drift in the area near the park. The eastern pocket between the pier and the eastern part of the shoreline was not as severely eroded as the western portion (figure 3) page 72. Furthermore, floating debris in the form of timber and tree trunks which collected parallel to the shoreline provided a weak and ephermeral form of shoreline protection. However, during severe storms, strong waves would serve to use this debris as battering rams to pound the shoreline.

The Lake Park site serves as a good example of an urban shoreline hazard arising from coastal erosion. Recession rates determined at this location were the highest noted for any of the four sites. In addition, the limited


SITE 2: LAKE PARK, ASHLAND, WIS.
PLAN VIEW Scale: 1in=100ft.
N
LAKE SUPERIOR
A
A
B
B
C
C
PARK
PROFILES Scale: 1in= 20 ft.
27'
Rotational slump
Modified Slope
Clay bluff
ALP-1
ALP-2
ALP-3
Section A-A
Section B-B
Section C-C

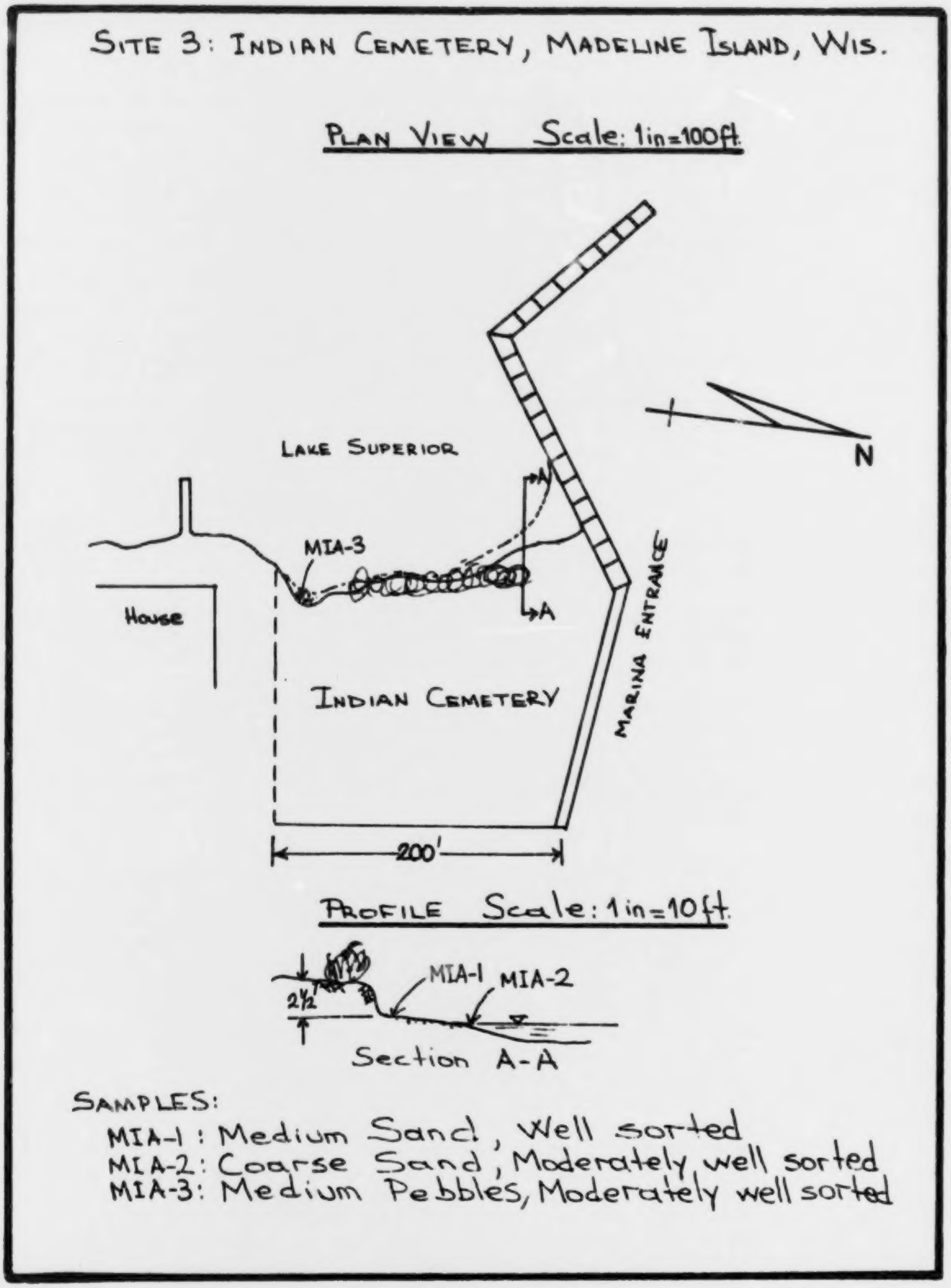
SAMPLES:
ALP-1: Coarse Sand, Moderately sorted
ALP-2: Inorganic "Red Silty Clay", Low Plasticity
ALP-3: Coarse Sand, Moderately sorted

Figure 3 Geometrical Characteristics of Site 2

effectiveness of man-made shoreline modifications and remedial structures is clearly evident at this site. Whether these structures or changes have accelerated the erosion action was not established during this initial survey. Therefore, this location does not offer the desirable type of setting in which the effectiveness of any proposed protective structure(s) can be evaluated with respect to the natural or pre-existing environmental conditions. However, it is evident that the site requires immediate remedial action because of the imminent land losses stemming from continued erosion of an urban shoreline area of high aesthetic and recreational value.

Site 3 - The Indian Cemetery Shoreline on Madeline Island, about 1/2 mile south of the village of LaPointe. This site occupies a very low terrace some one to two feet above the present level of the lake (figure 4) page 74 . A dog-leg shaped breakwater (a rock-filled timber crib) was constructed to protect the entrance to the Madeline Island Marina located just north of the Cemetery site. While the current regime in this part of Chequamegon Bay is unknown, it appears that the inshore movement of water may have caused the accretion of relatively coarse sediments in the angle formed by the breakwater and the northern part of the lakeshore property.

A line of shrubs and low woody vegetation parallels the property at the water's edge. Under conditions of lower lake levels, the overgrowth would appear to offer a moderate degree of protection to the shoreline from waves generated by west and southwest winds. However, at the time of the survey, the level of the lake was high enough to permit inundation of some of the shrubs that grew quite close to the waterline. Furthermore, long tongues of wave-deposited sand were found to extend right into the cemetery plots in a direction normal to the shoreline. These narrow sheets of sand are rapidly choking off the indigenous vegetation so that the protection afforded by the matted roots and undergrowth is being severely diminished. It also appears that this depositional process is irreversible, that is, the sand tends to remain trapped in the grassy parts of the cemetery and does not wash back into the bay. Under the present circumstances, the life expectancy of this historical site will depend almost entirely on the line of defense offered by the existing vegetation. Once the plant growth dies off and is removed by wave action, the property will be subject to very rapid erosion and possible flooding. Hence, a strong protective structure running parallel to the shoreline is needed immediately if the historical value of this site is to be preserved.


SITE 3: INDIAN CEMETERY, MADELINE ISLAND, WIS.

PLAN VIEW Scale: 1in=100ft.
LAKE SUPERIOR
N
A
A
MIA-3
HOUSE
INDIAN CEMETERY
MARINA ENTRANCE
200'
PROFILE Scale: 1in=10ft.
2½'
MIA-1
MIA-2
Section A-A

SAMPLES:
MIA-1 : Medium Sand, Well sorted
MIA-2 : Coarse Sand, Moderately well sorted
MIA-3 : Medium Pebbles, Moderately well sorted

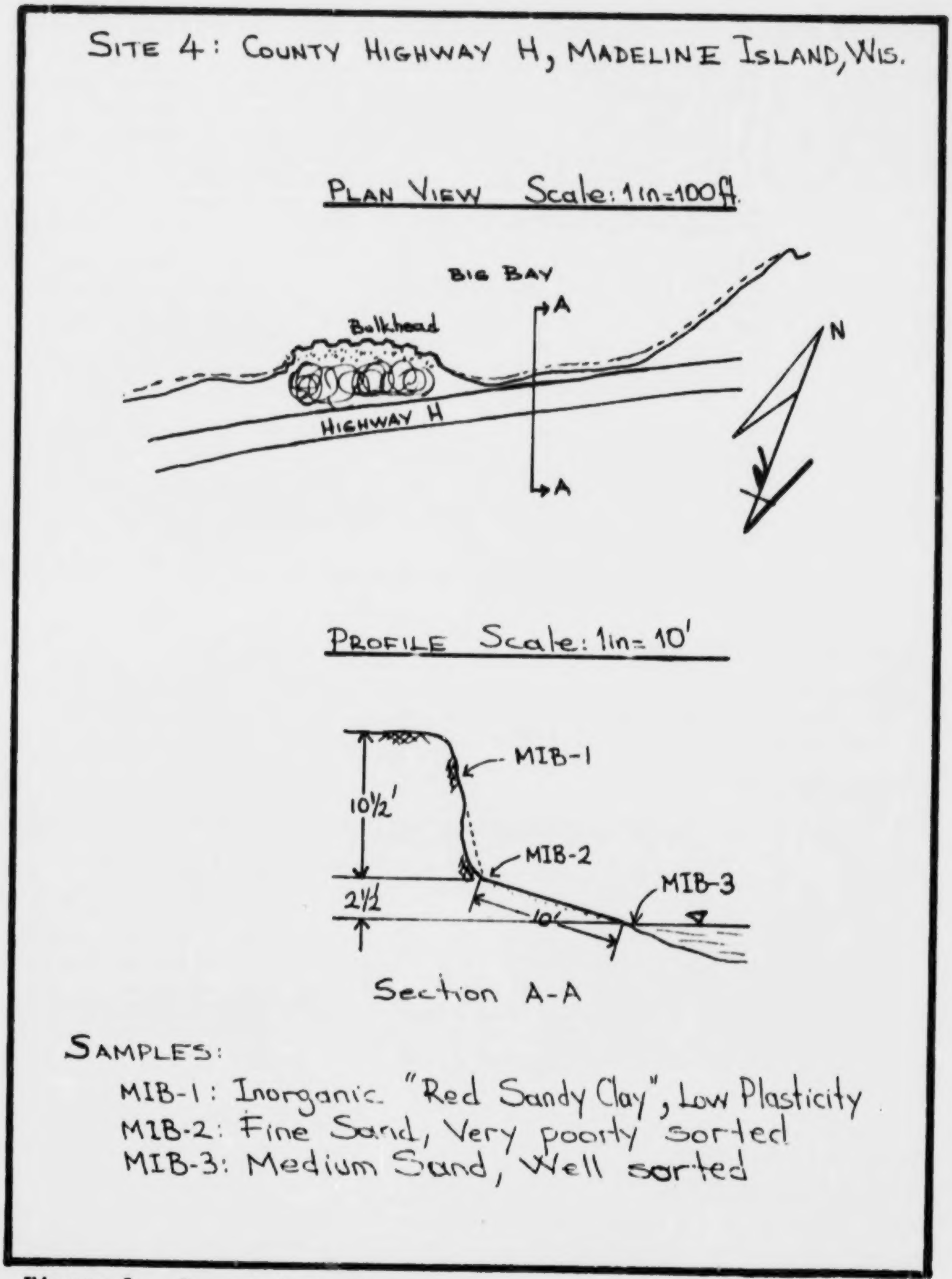
Figure 4. Geometrical Characteristics of Site 3

Shoreline losses at the Indian Cemetery on Madeline Island are not as great as at the other locations. With an estimated volumetric change of about only 0.1 cu. yd/ft/yr, the total amount of sediment load contributed to the nearshore zone of the bay is not substantial. However, this site provides a good example of a very low terrace-type of shoreline which has been stabilized with sod, bushes and some trees. Shoreline segments of this type also have been noted in the City of Ashland and along other parts of Madeline Island. While higher rates of shore material loss are not evident here, a peculiar situation exists in that wave-deposited sand is gradually choking off the indigenous vegetation and thereby reducing the protection afforded by the plants. Such a process is gradually encroaching on the cemetery plots in that the historical value of this site is being seriously endangered. Since the site entertains considerable problem visibility in terms of a tourist attraction, it merits immediate attention if it is to be preserved from further damage by wave action and wave deposited sand.

Site 4 - The southern side of County Highway H, where it runs parallel to Big Bay, approximately 9 miles northeast of LaPointe on Madeline Island.

The examination of this site was prompted by the recent collapse of part of the roadway into Big Bay (figure 5) page 76. Active undermining of the 'red clay' deposits along the northern part of the bay has severely cut back a large segment of the banks to within a few feet of the road pavement.

The surface of the road at the site of the bank failure is about 10.5 feet above the upper (inshore) edge of the beach face. At the time of the survey sea state was low and the beach face was about 10 feet wide. Just east of the point of failure, a sheet pile bulkhead was emplaced by the riparian owner(s) along the beach parallel to the shoreline. Apparently this structure was built there to protect a small stand of large trees growing near the water's edge. While the bulkhead did serve the purpose of shoreline protection as intended by the owner, active erosion has already worked around the ends of the structure. Undermining and bank collapse and natural wave-induced excavation of the sand fill near the flanks of the structure were much in evidence. Hence, as noted at Lake Park in Ashland, the efficacy of any shoreline protection or remedial structure can only be as good as the extent to which the protection completely envelopes the problem area.



SITE 4: COUNTY HIGHWAY H, MADELINE ISLAND, WIS.

PLAN VIEW Scale: 1in=100ft.
BIG BAY
Bulkhead
A
A
HIGHWAY H
N
PROFILE Scale: 1in= 10'
MIB-1
10½'
MIB-2
2½'
10'
MIB-3
Section A-A

SAMPLES:

MIB-1: Inorganic "Red Sandy Clay", Low Plasticity
MIB-2: Fine Sand, Very poorly sorted
MIB-3: Medium Sand, Well sorted

Figure 5. Geometrical Characteristics of Site 4

County Highway H in northeastern Madeline Island has been endangered along certain sections by shore erosion which has caused serious bank failure and partial collapse of the roadway. The site is an example of a low 'red clay' bluff, the uplands of which have been fairly well developed. The cover of glacial drift deposits of 'red clay' along the northeastern part of Madeline Island is relatively thin. Along the northern side of Big Bay, where County Highway H comes very close to the bluff crest, reddish brown bedrock was noted at the level of the bay. Sediment contribution to the nearshore zone of Big Bay is much less than at either the Madigan Beach or the Lake Park sites. Volumetric displacements of shoreline materials have been calculated to be on the order of 0.4 cu. yd/ft/yr.

The problem that is evident here and which requires immediate attention, is the hazard to vehicular traffic created by the undermining of the roadway. Setbacks over future roadway relocations can provide only a temporary solution; protective measures must be developed which will halt the process of undermining and thereby preserve not only the highway, but the nearby developed property as well.

Study Area Site Selection

Based on the recommendations contained in the preceeding section, the Madigan Beach and Indian Cemetery sites were chosen as the high priority sites for demonstration.

Demonstration

The Indian Cemetery Site

This site is on Madeline Island about 1/2 mile south of the village of LaPointe. This site occupies a very low terrace, some one to two feet above the present level of the lake. It is partially protected by indigenous vegetation and subject to some accretion by wave-deposited sand in the corner formed by the breakwater and the northern part of the lakeshore property. There is about a 200 foot long shore segment to be protected here. This site is of inestimable historical value and of high visibility to tourists and other riparian property owners.

It is hard to delineate the natural shore processes at this site due to the existence of man-made structures. There is evidence of some littoral drift in this area. However, because of developed neighboring property and possible interaction of groins with adjacent shoreline it is not advisable to install a groin type of installation here. Furthermore, the amount of littoral material and its characteristics as well as the interference of adjacent man-made shore structures with this segment of shore are poorly assessed at the present time. Due to the immediate nature of the problem, a positive solution is required. Bathing and recreation on the shores of this site are not anticipated. On the basis of these considerations, a revetment type of protection is recommended. The type of structure and material can be a rock-mastic, a Longard tube (sand-filled plastic tube), rubble, or a gabion (rock-filled wire basket).

Rock-mastic has been designated as a successful structure with definite potential as permanent means of shore protection by Brater, Armstrong and McGill (1975). A major drawback to this European technique is that an experienced local asphalt materials engineer and construction company are required to design and install this structure. Furthermore, some people may view it as lacking aesthetic qualities.

Gabions may have similar objectionable qualities in terms of aesthetics. Furthermore, in a low terrace shore like at the Indian Cemetery site, they may not prove compatible with the bank topography.

Longard tube is also a European technique which has been marketed in the U.S. for the last few years. It appears to be more suitable for the Madigan Beach site. It is still at an experimental stage in the Great Lakes. In view of the positive protection requirements of the Indian Cemetery site, and for more diversity in the demonstration project, a rubble revetment is recommended at this site. There are some examples of rubble protection on Madeline Island along the same shoreline and, apparently, they are performing satisfactorily.

On the basis of a design wave height of 2-4 feet, the general configuration of the revetment is determined and given in figure 6, page 79. A filter cloth is recommended to be used underneath the revetment in addition to the gravel and small stone filter.

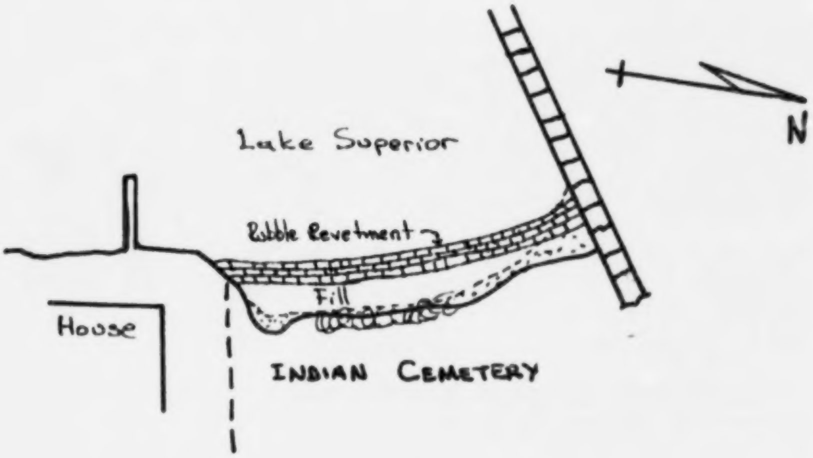
The land at the Indian Cemetery is low and some overtopping is evident. Therefore, the crest of the revetment should be somewhat higher than the present terrace grade. Furthermore, small groins can be placed in the revetment and extended back into the land. The other alternative is to build the revetment without groins, and if significant overtopping occurs, a rubble breakwater can be placed at critical sections to slow down the waves.

The Madigan Beach Site

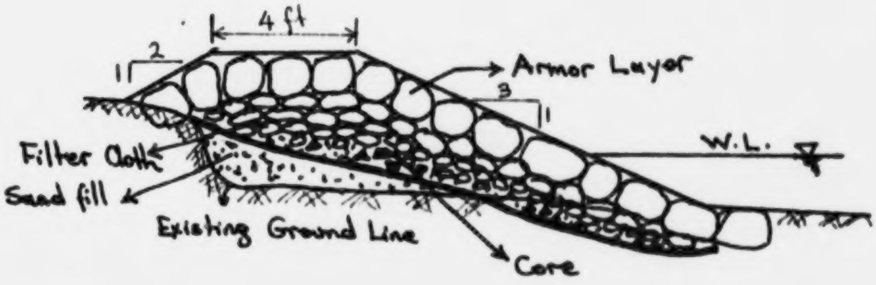
This site is located along the Lake Superior shoreline about 1-1/4 miles west of the Iron County line in the Bad River Indian Reservation. It is a high 'red clay' bluff which is undergoing rapid erosion in an unsettled and undeveloped area along an unprotected, open environmental setting, the intrinsic

INDIAN CEMETERY, MADELINE ISLAND, WIS.

PLAN VIEW Scale:1in=100 ft.


N
Lake Superior
Rubble Revetment
Fill
House
INDIAN CEMETERY

TYPICAL SECTION Scale 1in=5ft


4 ft
2
1
Armor Layer
3
1
W.L.
Filter Cloth
Sand fill
Existing Ground Line
Core

Assumed Design Wave Height = 2 to 4 feet
Required Weight of Individual Armor Units = 500-1000 pounds
Crest Width = 4 feet (minimum 3 ft)
Armor Layer Thickness (also size of armor stone) = 1.5 to 2 ft.
Approximate Number of Armor Units for the
Surface Area = 10

Figure 6 Preliminary Shore Protection Design Concepts, the Indian Cemetery Site

value of which is the aesthetically pleasing view. The Madigan Beach site is quite representative of a 12-mile long distinctive reach of shoreline undergoing critical erosion.

Since it is not a requirement to have an absolute means of protection at this site, the selection of the method and structure can be allowed to be influenced by the expressed objective of the project: to demonstrate and test shore protection procedures and types of construction. Cost is an important constraint; because even small savings per foot may amount to large sums if these experimental procedures are adopted in future for the protection of larger segments of the shoreline along the same coastal reach. The selection of a test procedure is also influenced by the need to innovate with the objective of keeping costs low. Consideration also has to be given to the compatibility of protective measures with the type of shoreland use at the Madigan Beach site. These considerations make the protective beach type of a solution as the most suitable for this environment. Because of the uncertainties at present about the coastal processes at this site (there are no existing coastal works), it is advisable to incorporate some structural method in the formation of protective beaches. This involves basically groins. Structural protection provided at this site must interfere least with the use of this shore for recreational purposes.

In view of these comments, the Longard tubes are found to be the most suitable for this site. These tubes were initially developed in conjunction with the Danish Institute of Applied Hydraulics. They have been tried in Holland, Germany, and recently, in Michigan. At some locations, they have performed very well, while at other locations, their performance has been questionable (Brater, Armstrong and McGill, 1975). Errors in design and lack of care during construction can easily render a shore structure to perform deficiently.

Longard tubes consist of large diameter flexible tubing in lengths of 330 feet or more filled using available materials, usually sand, for hydraulic filling. It has an impermeable inner tube manufactured in 28, 40 and 69-inch diameters. The outer protective material is woven, flexible, permeable polyethylene. A polyester spray-on coating makes the tube impervious to vandalism. Large diameter tubes weigh about 3,000 pounds/foot. A filter cloth is usually laid beneath the tube, especially on sand, to prevent backwash or toe scour and eventual tube settlement.

In the demonstration project at the Madigan Beach site, a field experimentation of some design parameters should be undertaken. Main emphasis should be given to the groin approach. It is expected that about 2,000 to 3,000 feet of shoreline at this site will be included in the demonstration. Approximately one third of this shore segment can be devoted to shore-parallel protection (seawall type) and two thirds to groin type protection. Furthermore, the effect of beach nourishment in conjunction with these structures will also be studied. In developing a field demonstration of these tubes, variation of the following parameters are recommended to be studied:

1. Seawall versus groin performance.
2. In the case of seawall: the modification of bluff slope versus no modification, seawall size, and effect of filter cloth.
3. In the case of groin: length, size, and spacing of tubing; effect of filter cloth.
4. Combined effects of seawall, groin and beach nourishment.

A suggested lay-out of Longard tubes which allow investigation of these parameters is given in figure 7, page 82. The actual number of groins and the length of seawalls may vary somewhat due to the budgetary constraints. However, the general principle of the layout can be maintained.

Monitoring and Evaluation

The objectives of the project monitoring and evaluation program will include (a) cost-effective analysis of the demonstrations, (b) accumulation of pertinent engineering data in this area, both for meaningful analysis of performance and for future design of protection structures.

In order to meet these objectives, monitoring should be carried both at the demonstration sites as well as at control sites with no protection. This approach would provide valuable comparisons and information about the coastal processes operative along an unprotected, open environmental setting.

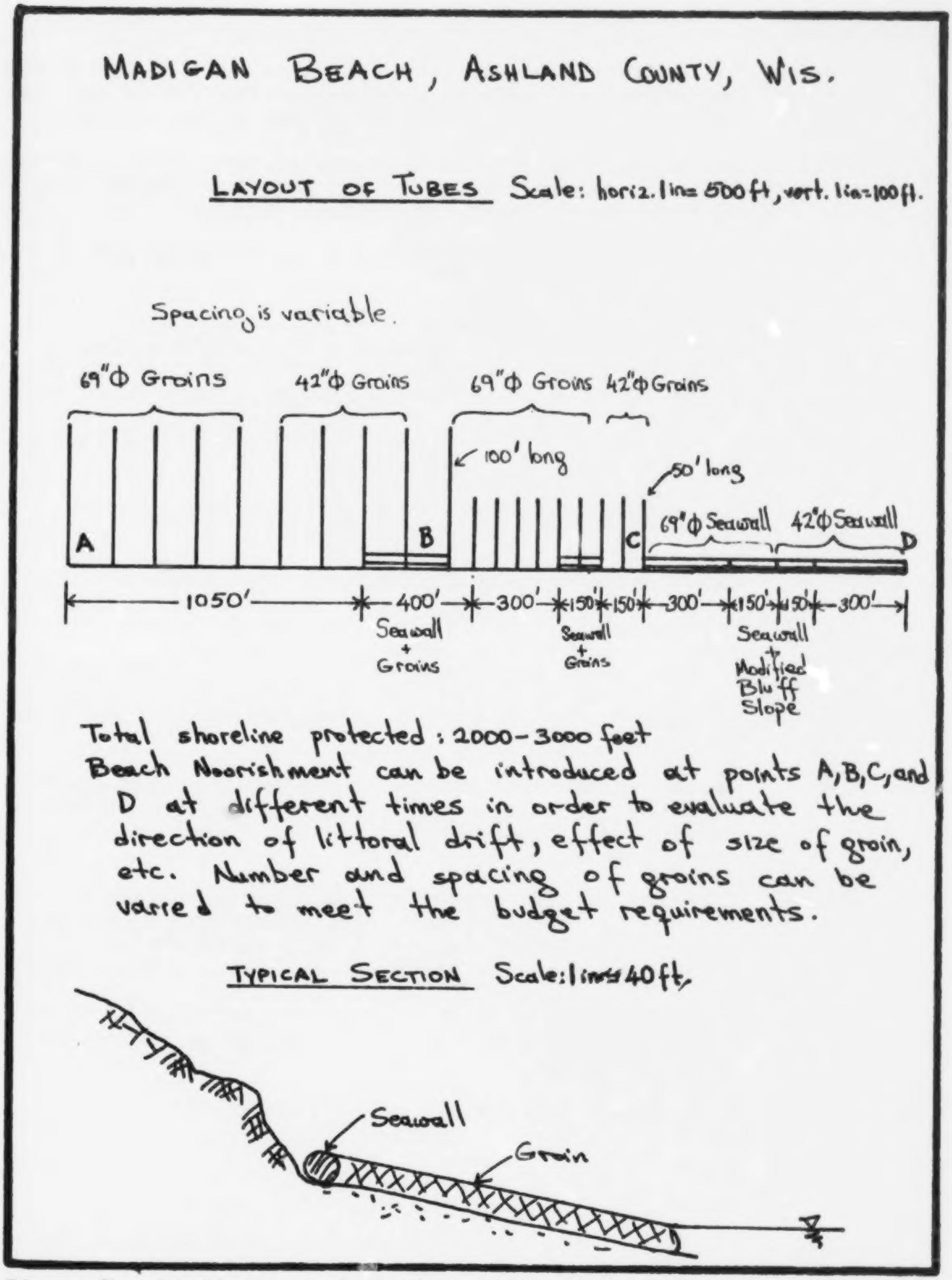
The monitoring project will address itself to the following specific objectives:

(i) to establish the specific characteristics of the shore bluffs which has immediate bearing on the problem of coastal erosion. These include the geology of the glacial till bluffs, their textural, mineralogical and mechanical characteristics;

(ii) to identify historical and present day geometry of the shoreline and beach zone;

(iii) to evaluate the immediate offshore sediment characteristics and their aerial distribution and to relate the composition of the bluff materials to the offshore sediment budget;

(iv) to assess the dynamics of the coastal zone in terms of wave action, littoral currents and lake level fluctuations;



MADIGAN BEACH, ASHLAND COUNTY, WIS.

LAYOUT OF TUBES Scale: horiz. 1in= 500 ft, vert. 1in=100 ft.

Spacing is variable.

69"Φ Groins
42"Φ Groins
69"Φ Groins
42"Φ Groins
100' long
50' long
69"Φ Seawall
42"Φ Seawall
A
B
C
D
1050'
400'
300'
150'
150'
300'
150'
150'
300'
Seawall + Groins
Seawall + Groins
Seawall + Modified Bluff Slope

Total shoreline protected : 2000-3000 feet
Beach Nourishment can be introduced at points A, B, C, and D at different times in order to evaluate the direction of littoral drift, effect of size of groin, etc. Number and spacing of groins can be varied to meet the budget requirements.

TYPICAL SECTION Scale: 1 in = 40 ft.

Seawall
Groin

Figure 7 Preliminary Shore Protection Design Concepts, the Madigan Beach Site.

(v) to establish recession rates, which can be attributable to direct or indirect processes operating in the coastal zone, using aerial photography and ground surveys;

(vi) to survey the movements of the protective structures and damages to them in relation to the storms, their overall performance, and effectiveness;

(vii) to interpret the results both analytically and physically.

The approach includes (a) field surveys and sampling, (b) laboratory testing of samples (textural and engineering), (c) periodic profiling at demonstration sites as well as in control sites, (d) photoreconnaissance immediately after major storms, (e) aerial photography surveys and recession rate analyses, (f) determination of the nearshore zone bathymetry, and (g) damage survey of the structures.

Monitoring results from this study will have short and long term applications:

(1) will serve to identify specific environmental factors which contribute directly to the problem of shoreline erosion.

(2) 'continuous' monitoring will provide a 'time-lapse' sequence of which can relate given slumping-recession processes to the dynamic characteristics of specific events.

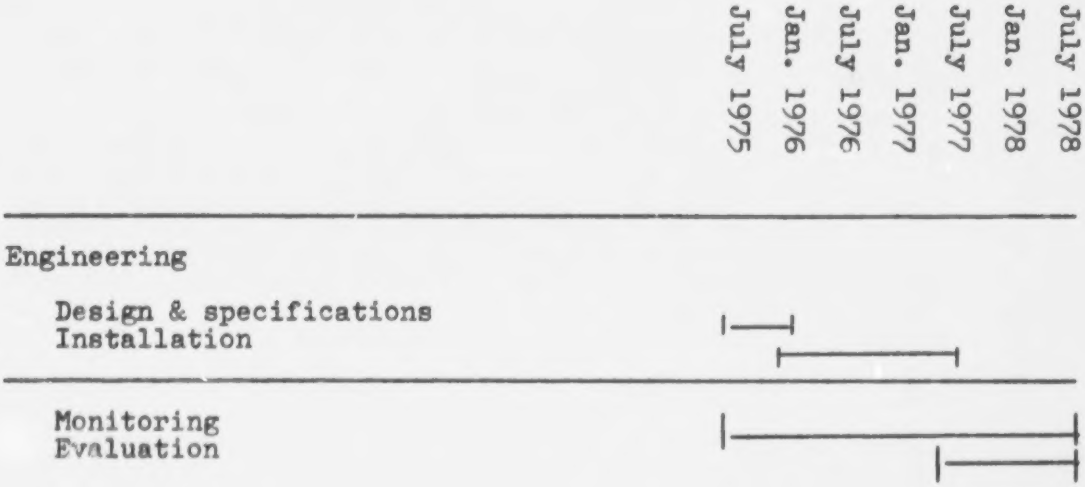
(3) will provide engineers with a meaningful data base whereby the most economic and efficient protective measure can be designed and installed along the coastline.

(4) provide coastal zone planners with the necessary technical information to develop a management plan and policy guidelines which will serve the best interest of the riparian landowner and coastal user.

(5) provide meaningful data for the estimation of direct sediment contributions to Lake Superior from highly erodible areas.

TABLE 18 WORK PLAN
TIME SCHEDULE

Ashland Shoreline Study Area



VII. INFORMATION DISSEMINATION AND EDUCATION

Introduction

The success of the Project is heavily dependent on the ability of the Soil and Water Conservation Districts to assimilate the work of a number of technical agencies and institutions and to promote their recommendations throughout the local jurisdictions so as to assure full and effective implementation for demonstration purposes. The variety of suggested measures ranges from structural modifications to non-structural regulations and from prevention to control, with the overriding evaluation measure being cost-effectiveness. A highly critical element in the success of such an action-oriented program will, necessarily, be the public's understanding and acceptance of the general red clay problem, the Red Clay Project's goals and objectives as well as its specific recommendations as they are advanced.

Goals and Objectives

The broad goal, then, of the information and education program is to have a diverse group of target audiences at local, state and national levels become aware and knowledgeable of red clay erosion and sediment problems and alternate solutions to these problems as they are developed by the activities of the Red Clay Project.

In working toward this general goal, there are several key objectives which must be met. These are:

1. Increase public understanding of the problems associated with red clay soils in the region.

2. Increase public understanding of the full range of possible preventive and corrective measures for handling these problems.

3. Improve public awareness of the purpose and progress of the Wisconsin/Minnesota Western Lake Superior Basin Erosion-Sedimentation Control Project, including especially, a sensitivity to the unique demonstration points cited for each Soil and Water Conservation District's project.

4. Improve public awareness of the potential environmental and economic impacts associated with the erosion and sedimentation control program.

5. Provide forums through which the public can participate in reviewing specific aspects of the program.

6. Provide forums through which the public can participate in implementing specific program recommendations, such as land use planning and regulatory controls.

Target Clientele and Audience Groups

The complexity of the Red Clay Project demands an information and education delivery system which has the capability to effectively represent it at various local levels as well as in areas far removed from the demonstration sites. At these various levels the program must be clarified, explained to, and discussed with both public officials and private individuals and groups, professional personnel and lay people. Additionally, it will be necessary for the executors of an information and education effort to work closely with groups related both formally and informally to the overall Project and the problems it addresses. The audience groups to be addressed by the information and education program are listed in Table 19.

Forums and Formats

An information and education effort for a project of this type and magnitude must draw freely from the full range of available delivery mechanisms. Six distinct types of forums and formats are indicated as follows:

1. A series of conferences, workshops, public meetings, and tours will be held throughout the lifespan of the Project. They will be devoted at first to general problems and needs and changing, over time, to focus on specific problems and Project progress. The work elements listed below will be systematically coordinated with each other and with overall Project activities.

    a. A series of conferences--At least once a year, planned conferences will be held at central locations for interested technical and professional personnel at the county, multi-county, state and national level. Technical information, project progress, publications and papers will be presented at these conferences.

    b. Series of workshops--These will be primarily by basin and for local officials and interested citizens. At least two workshops per year will be held in strategic locations in the area of the Red Clay Project to provide forums for participation on Project status and review.

    c. Series of planned public meetings--At least two public informational meetings will be held each year in strategic locations within the Project area, on the problems, possible alternatives, and status of the Project.

Table 19
Target Clientele and Audience Groups*

Local & Multi-county Levels

News media (& general public)
County boards
Service clubs
State agency personnel (field based)
RP&DC's
Area associations of SWCD's

SWCD Supervisors
Town boards
Landowners
Schools (primary & secondary)
RC&D's
Watershed associations

City and Village Councils
Voluntary Organizations (those concerned with environmental matters)
Federal agency personnel (field based)
University & College faculty
Councils of government

State Level

State associations of SWCD's
State legislators
Statewide Voluntary Organizations (*e.g.* League of Women Voters, RCIC, Northern Environmental Council, etc.)

State agencies
- WBSWCD, MSWCC
- WDOT
- State Planning agencies
- WDNR, MDNR
- Health agencies
- Water Quality & EPA's

State Executive Offices

Federal agencies (selected state personnel)
Statewide news media

Multi-state and National Level

UGLRC
NACD
US Army Corps of Engineers
USDOT

SWCD's
USEPA
USDA agencies (selected)
US legislators

GLBC
US Dept. of Commerce
USHEW

Other appropriate US agencies, institutions & organizations

International Level

IJC

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*for full definition of abbreviations used see Table 1 (page 3).

d. Series of planned service-club-type meetings--A speaker's packet will be prepared so the Project Director or his representative can make presentations on the Red Clay Project at service-club-type meetings when requested to do so. As the Project progresses, this packet will be kept current.

e. Series of field tours--At least two on-site tours of each demonstration project will be held each year in the Red Clay Project area. The clientele is to include professionals and interested citizens.

2. The media--radio, TV, newspapers, and newsletters will regularly be provided with pertinent information reporting generally related issues as well as specific developments as the work of the Project progresses. In this regard, the executors of the outreach effort will be encouraged to use both their serial columns and slots as well as other media formats.

   a. Radio specials--At least two fifteen-minute radio programs will be scheduled each year to be presented on tape to each of the stations in the Project area. These tapes will deal with progress or status of the Project and can include interviews of specialists involved in the Project.

   b. TV specials (video-taped)--At least two, thirty-minute TV specials will be scheduled per year to be presented to each of the TV stations that have viewing audiences in the Project area. These also will be carefully planned and should include specialists involved in the Project and include progress in any of the demonstration areas.

   c. Newspaper specials--At least once a year, a Sunday edition special or series will be presented on the status of the Project. The specials may be timed to coincide with the completion of pertinent demonstration or research activities.

   d. TV, radio, newspaper--The Project Director and staff will keep these media informed on a regular basis of news developments on the Project. If county agents have a regular radio, newspaper column or TV slot they will also be kept informed of Project developments, so this material can be presented through the media.

   e. Newsletter special--A specific Red Clay Project Newsletter will be developed and an appropriate mailing list established. In addition, the Project Director and staff will keep other sponsors of newsletters, such as Regional Planning Commissions and RC&D projects, informed of events for publicity to be used in their regularly scheduled newsletters.

3. Special attention will be given to the presentation of technical work progress and reports of the Project through public orientated formats such as prepared fliers and slide-tape sets.

    a. Fliers (brochures)--A flier or brochure or series of brochures that describe the problems and Project objectives will be developed and appropriately disseminated.

    b. Slide-tape documentary--A narrative slide presentation will be developed concerning the Red Clay Project and will be maintained and modified as changes in the Project develop. This slide set presentation can be requested by public interest groups to inform their clientele of Project development and activities.

4. The preparation and use of materials such as physical models of the Project areas, maps, and photographic representations will be accomplished in such a way as to meaningfully involve non-program related groups such as school groups and other interested organizations.

    a. A three dimensional physical model--Appropriate models will be developed of each of the study areas and will include the demonstration sites and structures as they are developed. These will be mobile displays or exhibits for use at public meetings and in classrooms or window displays.

    b. Illustrative maps--A set of five illustrative relief maps of the total Project will be developed with demonstration sites and structures indicated. These maps will be displayed in different selected sites of the total Project area for review by the general public.

    c. Photos--Specific demonstration site projects will be illustrated through a series of photos for each basin. These photos will be used to embellish the mobile displays.

5. Soil erosion and sedimentation control programs such as the Red Clay Project are recognized as a first line defense in a broad non-point pollution control program. Under Section 108 of PL92-500, several such projects are underway in the Great Lakes Basin. A film for national distribution will be made of the Red Clay Project. This film may also include portions of other, similar, 108 projects. There are two others which may be included in the film. They are the Black Creek Watershed Project in Indiana and the Washington County Project in Wisconsin.

VIII. INSTITUTIONAL MANAGEMENT SYSTEMS

Introduction

The Red Clay Project is a unique and complex demonstration program involving two states, five local units of government (SWCD's) and several cooperating governmental agencies and non-governmental institutions. The total Project area lies within the western Lake Superior watershed basin, however, within this basin, there are five separate subwatersheds or study areas. Each of the five SWCD's has within its geographical boundaries one of the five study areas. In addition, each of the five study areas has its own goals, objectives and demonstration activities to be performed, monitored and evaluated.

In a project of this magnitude and complexity, it is difficult to segregate the variety of activities for discussion purposes and then to reintegrate them in order to relate them back to the overall Project goals. This process, however, is crucial to the effectiveness of the research and demonstration project. To do this requires a complex institutional management system.

The management system, no matter how complex, must be clearly delineated. A full understanding is needed of the inputs from participating agencies and institutions and the operating characteristics of regulatory and implementing authorities. This understanding is essential in order to help secure the needed cooperation, to help reduce the possibility of duplication of efforts and to help prevent potential conflicts with other programs.

The institutional management section of the work plan will briefly review the legal authorities making the Project possible. It will then outline the Project goals and objectives, explain how each participating institution's activities will complete objectives which lead to the fulfillment of the Project's goals. The internal management system will be discussed to indicate how the various components of the Project fit together and the Project's goals can be achieved.

Legal Authority

Local Authority

SWCD's, which have been in existence since the mid 1930's, have been actively involved in the whole process of non-point source pollution control, including erosion and sedimentation control. The four SWCD's in Wisconsin were created pursuant to Wisconsin Statutes 92.05 and the one SWCD in Minnesota was organized according to Minnesota Statutes 40.00. All five SWCD's are special purpose units of state government with the legal authority to plan and implement erosion and sediment preventive and control measures within their jurisdictions (Chapter 92, Wisconsin

Statutes and Chapter 40, Minnesota Statutes). As special purpose units of government, the SWCD's are empowered with the authority to cooperate with, and enter into agreements with, other equally empowered units of government and agencies (Wisconsin Statutes 92.13, 66.30 and Minnesota Statutes 40.01, 471.59).

Federal Legislation

The first federal legislation to provide a basis for broad federal agency participation in water quality management was the temporary Water Pollution Control Act of 1948. A more comprehensive law was adopted in 1956, strengthened by the 1961 amendment and further amended, strengthened and broadened by the Water Quality Act of 1965. In 1972, Congress enacted a major landmark revision of these national water quality programs with its passage of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500).

Under these laws, federal activities for improving water quality were instigated, broadened and increased to provide a wide variety of programs including those which provide for: research programs, technical and financial assistance for state and local programs, comprehensive basin surveys and plans for controlling water pollution, promulgation of standards of water quality for interstate waters, and enforcement actions for the abatement of pollution of interstate or navigable waters.

It was the passage of PL 92-500 which added impetus to the drive to clean up the nation's waters. This was done by placing an emphasis on strong action programs and devising viable enforcement techniques. A few of the more important provisions of this law, and those which relate to the Red Clay Project, include Sections 108, 305 and 314.

1. Title I - "Research and Related Programs", Section 108 - "Pollution Control in Great Lakes".

   This section provides authorization for the EPA to enter into agreements with, and provide assistance for, states or their political subdivisions to research and demonstrate new techniques for retarding or controlling pollution in the watersheds of the Great Lakes.

2. Title II - "Standards and Enforcement", Section 305 - "Water Quality Inventory".

   This section provides that the states and the EPA shall prepare water quality inventories which identify existing water quality problems of navigable waters, point and non-point sources of pollutants and recommended remedial programs.

3. Title III - "Standards and Enforcement", Section 314 - "Clear Lakes".

This section provides that each state shall prepare a classification of all publicly owned lakes including procedures, processes and methods (including land use treatments) to control sources of pollutants and thereby beginning the process of restoring water quality.

Goals and Objectives

The specific activities, objectives and goals to be accomplished in the five separate study areas have been previously discussed. It has been particularly difficult to discuss these objectives and activities separately because there is a considerable amount of overlapping of activities of one research program covering more than one study area. In essence then, there are five study areas, each having its own objectives and demonstration activities; a variety of research activities with their own objectives, not necessarily related to the study area objectives in each case; several project-wide, self-contained programs with their own objectives; and finally, a set of Project goals and objectives to which all of the previously mentioned objectives and activities must be related.

The ultimate goal of the Project is to research and demonstrate methods of enhancing water quality through the use of erosion and sedimentation control techniques (structural, non-structural, institutional and managerial) on geologically young, highly unstable clay soils. The planning phase of the Project has developed five secondary project goals, each with its own set of objectives. These goals are:

Goal I	The development of recommendations and plans for SWCD's to develop long-term, basin-wide programs for erosion and sedimentation control.
Goal II	The development of institutional arrangements for implementing basin-wide programs for erosion and sedimentation control.
Goal III	The implementation of cost effectiveness analyses on the techniques demonstrated during the life of the Project in order to provide a guide to SWCD's in implementing long-term control programs.
Goal IV	The demonstration and evaluation of new or innovative techniques and methods for retarding, controlling or preventing erosion and sedimentation.

Goal V The promotion and installation of proper land use practices consistent with the capabilities and limitations peculiar to the highly erodible red clay soils.

Participating Organizations and Working Relationships

There are numerous institutions and agencies making direct input into this Project. Additionally, there are several others supporting the Project indirectly, making contributions where possible. This section will discuss the Project participants, their work activities and their relationship to the entire Project and other work groups.

International Organizations

1. International Joint Commission - (IJC)

The IJC is a permanent body established by the United States and Canada to carry out the purposes of the Boundary Waters Treaty of 1909. One of the major responsibilities of the IJC is to investigate and make specific recommendations on specific problems along the common frontier referred to the IJC by the governments of the United States and Canada. The IJC has been actively studying the pollution problems in the Great Lakes (including specific studies in Lake Superior) through its Pollution from Land Use Activities Reference Group (PLUARG).

Regular communication with the IJC has been maintained by the Project. The Project Director is a Technical Specialist for "Task C" of PLUARG. "Task C" is the detailed survey of selected watersheds to determine sources of pollutants, their relative significance and the assessment of the degree of pollutant transmission to boundary waters. Additional liaison between this Project and IJC is accomplished through the regular interaction of the USEPA and the IJC.

Federal Agencies and Programs

1. United States Geological Survey - (USGS)

The USGS will contract with the Project to do the water quality monitoring work in the Skunk Creek, Little Balsam, Pine Creek and Spoon Creek study areas. The types of monitoring stations, their locations and the parameters to be measured have been discussed in the monitoring sections of the respective study areas.

Water quality monitoring will play an important role in evaluating the overall success of the Project as well as the success of the specific control techniques being monitored. In that all techniques will be subjected to evaluations and cost effectiveness analyses, it will be imperative to determine the actual effectiveness of specific techniques in reducing sediment load.

In the Wisconsin study areas, USGS and the Project will receive assistance from the WDNR for water quality monitoring. USGS and WDNR will maintain close liaison with each other and with the Project to insure the accumulation of useful data. The data produce will be of direct use to the research being conducted in each of these study areas.

2. Bureau of Indian Affairs - (BIA)

One of the sites selected for shoreline demonstration projects is situated on land owned by the Bad River Indian tribe. The Indian tribe has been kept informed of the Project intentions and has shown an interest in the successful application of the proposed demonstration projects. The BIA has aided in securing the endorsement for these projects from the Bad River Tribal Council.

3. Department of the Army Corps of Engineers - (the Corps)

The Corps has the responsibility for the maintenance and protection of harbors and shorelines. The Corps also is the permitting agency for any structural work that may be done in these areas.

From the onset of the Project, communication has been maintained with the Corps. When appropriate, all designs and specifications will be submitted to them for compliance with permit regulations.

4. USDA Soil Conservation Service - (SCS)

The SCS is a federal agency which, unlike most large agencies, has close local contact with field based personnel in nearly every SWCD. This agency provides technical planning and implementation assistance to all SWCD's and furnishes leadership and expertise in the development of district programs.

Although SCS is one federal agency, it is departmentalized into state, area and district units of operation. These units normally work only within their own geographical jurisdictions. For purposes of the Project, a work force of several field and supportive personnel has been assigned to work within the entire project area. This has required the coordination and cooperation of two state units, two area units and five district units within the SCS.

In that SCS works closely with the SWCD's providing technical assistance for district programs, the Project will rely heavily on them for surveys, inventories, engineering recommendations and construction standards and specifications. They will also work widely with landowners to plan for, and help implement, necessary land use practices.

In addition to the ongoing district programs throughout the Project area, SCS will provide technical work for the Project in the Skunk Creek, Little Balsam Creek, Pine Creek and Spoon Creek study areas. Their work will be concentrated on the preparation and implementation of conservation farm plans; design work and specifications for certain structural measures; and general assistance for landowner contract administration, program development and evaluation.

State Agencies and Institutions and Organizations

1. Wisconsin and Minnesota Departments of Natural Resources - (WDNR and MDNR)

The DNR's of the two states are somewhat different in organization and structure but are still functionally similar in their relationships to SWCD's. The DNR's cooperate with SWCD's and other agencies in conducting surveys and evaluations leading to wise development of watersheds. The DNR's also advise the districts and landowners on the planning, development and utilization of resources. Further, technical and some financial assistance is available to the SWCD's from the Departments for preparing plans and implementing and evaluating activities for the conservation of natural resources.

The DNR's also function as the primary regulating and permitting agencies in the two states. In this capacity, the DNR's must approve designs and specifications of all work to be done on bodies of navigable waters falling within their respective jurisdictions.

2. Wisconsin Board of Soil and Water Conservation Districts - (WBSWCD) and Minnesota State Soil and Water Conservation Board (MSWCB)

These two agencies have similar functions in their respective states as the parent bodies or agencies providing policy guidance and assistance to SWCD's. The WBSWCD and the MSWCB work closely with SWCD's administering certain funds to districts, coordinating district programs and securing the cooperation of various local, state and federal agencies to plan and implement SWCD programs.

The WBSWCD and MSWCB will be working closely with the Project and its sponsoring SWCD's by acting in advisory capacities to the Project Executive Committee and the SWCD's. The WBSWCD has one full-time Project Specialist assigned to the Project, under contract; and the MSWCB will be working more closely with the Project through its reorganized and expanded staff.

3. Red Clay Interagency Committee - (RCIC)

This organization was formed in Wisconsin in 1954 to study the problems of the red clay soils in Northwestern Wisconsin and to make recommendations for correcting these problems. The RCIC has been a loosely structured organization, but one which has provided a considerable amount of useful background data and recommendations for the Project. The RCIC meets periodically and its members play a major role in advising the Project and evaluating the Project activities.

4. Institutions of Higher Education

Several colleges and universities throughout the two states have been instrumental in the preparation of portions of the information dissemination and education program, the Ashland Shoreline study area program, and the planned research programs. They will also be instrumental in implementing these programs.

Those institutions participating are: the University of Wisconsin-Madison, the Center for Lake Superior Environmental Studies of the University of Wisconsin-Superior, the Sigurd Olson Institute of Northland College, the University of Minnesota-Duluth and the University of Wisconsin-Milwaukee.

These institutions also have a multitude of programs involved with water quality of the Great Lakes and to a lesser degree with erosion and sedimentation control. Close liaison will be maintained to coordinate all ongoing activities between these institutions and the Project.

5. University of Wisconsin-Extension - (UWEX) and University of Minnesota-Extension (UMEX)

The Extension branches of the university systems are responsible for carrying on the educational function of the universities away from university campuses. They have been classified here as state institutions; however, they are complex institutions with federal (USDA) and county affiliations. Extension personnel are either state-based or area-based with state and federal funding, or they are county-based with state, federal and county funding.

County-based Extension personnel work closely with SWCD's planning and implementing the educational phases of district programs. State-based and area-based personnel add support services for the county personnel in working with SWCD's.

Both UWEX and UMEX will be working directly with the Project on the information dissemination and education program. In this capacity, they will be coordinating the efforts of all groups working on this program.

6. Wisconsin Department of Transportation - (WDOT)

The WDOT is intricately involved with the Red Clay Project on a cooperative basis. There has been and will continue to be a mutual exchange of information and materials which will prove beneficial to both parties. Through the research and demonstrations generated by the Project, the WDOT can obtain vital information on the erosive properties of the red clay soils for road construction and maintenance. Conversely, the WDOT provides the Project with considerable material and expertise concerning roadside erosion, subsurface deposits, road construction standards and specifications, etc.

Multi-county Agencies

1. Northwestern Wisconsin Regional Planning and Development Commission - (NWRP&DC) and the Arrowhead Regional Development Commission - (ARDC)

The service of the regional planning commission is that of advisory planning for the purpose of guiding the coordinated physical development of a multi-county region. Land use plans, transportation plans, and water and wastewater management plans are important results of regional planning commission efforts. The regional planning commission typically works closely with many federal, state and local government agencies and with private individuals and groups in the region. Local planning assistance is a major and significant regional planning commission activity.

The ARDC and the NWRP&DC will continue to relate to the Project through their normal activities with sponsoring SWCD's. Both commissions will continue to give planning, coordinative and administrative assistance to the Project. The NWRP&DC is also supplying the position for the Project Director under contract with the Project.

2. Resource Conservation and Development Projects - (RC&D's)

Each of the districts participates in a Resource Conservation and Development program on a local level. The Wisconsin Counties make up the Lake Superior Division of the Pri-Ru-Ta RC&D. Carlton County, Minnesota participates in the Onanegozie RC&D.

Both of the RC&D Projects were instrumental in initiating the Project and were active in the planning phase. They will continue to relate to the Project in an advisory capacity. Further, they will continue to operate in their normal fashion with their member SWCD's. The work performed by the RC&D's will be complementary to the Project's work. It is not the intent of the Project to replace these programs in any aspect. On the contrary, it is hoped that methods demonstrated by the Project may, in the long run, enhance RC&D programs.

Internal Management System

The Red Clay Project is sponsored at the local level by five Soil and Water Conservation Districts (SWCD's) in two states. These SWCD's have co-sponsored an application for federal funding under Section 108 of PL 92-500. While this application and the acceptance of the grant offer binds the SWCD's of the various counties together, the suprastructure created by this bond will be guided by a constitution and by-laws which will be formulated at a later date. This constitution and by-laws will provide the basis for an internal management system for the Project. To supplement the constitution and by-laws, an operations manual will be developed which will spell out the procedures for obtaining reviews and approvals of specific work items in a timely fashion.

While these five SWCD's represent two states, their interactions with the state agencies of Wisconsin and Minnesota are similar enough that we may discuss them on a project wide level rather than on a county level. The major difference between the SWCD's in the two states is that in Wisconsin the supervisors are selected from the local county board of supervisors and in Minnesota the supervisors are elected directly. In Wisconsin, by law, the SWCD supervisors are the members of the Agriculture and Extension Committee. This system allows for greater interaction with other local units of government and their committees, but it does promote a greater reliance of the SWCD on the county boards for funding and approval of activities. In Minnesota, the system of directly electing SWCD supervisors provides for a greater autonomy on the part of the supervisors, but it does tend to lessen the direct working relationship with other local units of government.

Wisconsin Statutes 66.30 and 92.13 and Minnesota Statutes 471.59 and 40.01 permit joint exercise by SWCD's of any power as duly required of or authorized to the SWCD by statutes enabling the SWCD to cooperate with other SWCD's or governmental units through intergovernmental contracts. These districts are the legally constitute authorities to carry out measures for the control and prevention of erosion and sediment damages. Soil and Water Conservation Districts, the boundaries of which in these two states coincide with county boundaries, are, for all intents and purposes, working parts of county government.

The district cooperates with landowners and occupiers in developing and implementing plans for soil erosion control, improved water management, and related objectives. The county board of supervisors, the federal Soil Conservation Service, the federal Agricultural Stabilization and Conservation Service, The University Extension Service and other state and local agencies, and private organizations collaborate with the Soil and Water Conservation Districts. In Wisconsin, the district may formulate land use regulations which, if adopted by ordinance of the county board, may require installation of various kinds of water-control structures on private lands, use of particular methods of cultivation, observance of specified cropping programs and tillage practices, retirement from cultivation of highly erosive areas, and other land management measures for conserving soil and water resources. Such land use ordinances, if adopted and enforced, could have substantial beneficial effects of improving the quality of the waters of streams and lakes. A bill to enable Minnesota districts with similar authority is pending.

1. Project Executive Committee

   The SWCD's have joined together by agreement to sponsor the Project. In order to facilitate project-wide decision-making, they have formed a Project Executive Committee consisting of equal representation from each of the five SWCD's. As mentioned, this is the ultimate decision-making body of the Project. Each SWCD representative acts as an intermediary between the Committee and his SWCD, relating information and seeking necessary SWCD approval for decisions directly affecting his or her SWCD.

   The Douglas County SWCD and its representative on the Executive Committee act as fiscal agent for the Project. In this capacity, it deals directly with the USEPA and implementing groups in all contractual and fiscal affairs.

2. Project Director

   The Project Director, hired by NWRP&DC and furnished under contract to the Project, is responsible for overall Project operations and making day-to-day decisions guided by the policy and decisions made by the Executive Committee. His job is administrative and coordinative. Working directly with the Executive Committee and the implementing groups, his job is to interpret Executive Committee policy to the implementing groups to insure the smooth operation of the Project.

3. Staff Services

   The Project Director has at his disposal the services of staff personnel to assist him in conducting project operations and seeing that the Project goals are met. The WBSWCD has supplied a full-time Project Specialist, under contract, to provide specified services to assist the Project Director. In addition, the Project has hired, through the Project's fiscal agent, needed secretarial services. If the financial parameters allow, there is also the potential for expanding the Project staff to include additional secretarial services, specialists, consultants, and assistants.

4. Advisory Bodies

During the formative and planning phases of the Project, several advisory committees and groups were in existence to advise the Executive Committee and the Project Director. These included: the Project Advisory Committee, the Technical Interagency Consortium, the Research Advisory Committee and the Information-Education Committee.

In addition, several non-project organizations and agencies were called upon for advice, assistance and planning evaluations. During the course of the implementation phase of this Project, these groups may be asked to reconvene on an ad hoc basis to assist with specific matters.

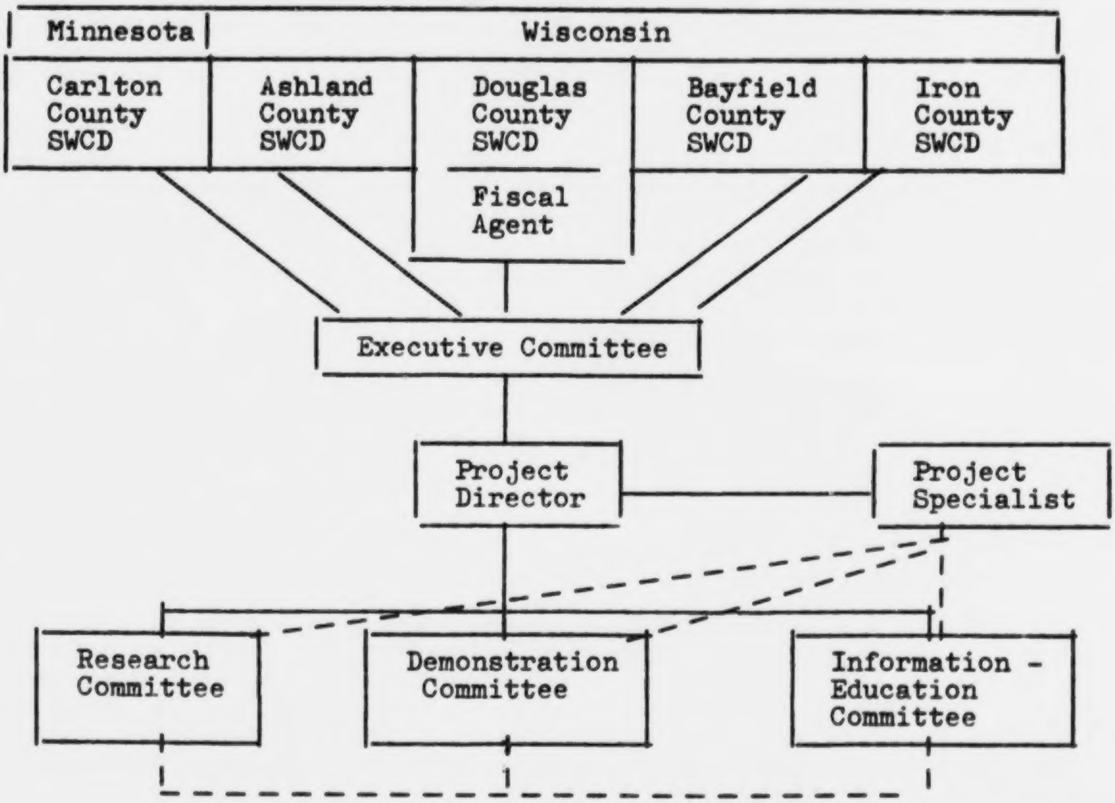
5. Implementing Bodies

To insure the timely implementation of Project activities and the completion of Project objectives and goals, three implementing bodies are recognized. The Research Committee, consisting of the principal investigators of contracted research activities and selected Project staff, is responsible for maintaining liaison with the Project Director, coordinating research activities, and seeing to the ultimate completion of all research aspects of the Project.

The Demonstration Committee consists of those principal investigators and Project staff responsible for the implementation of demonstration activities (i.e. structure installation, vegetative trials, land use practices, etc.). This committee will provide liaison with the Project Director, coordinate all demonstration activities, and supervise the installation of structures, trials, and practices.

The Information Dissemination and Education Committee consists of Project staff and those representatives from educational institutions responsible for information dissemination and public education. As with the other committees, they will work directly with the Project Director to keep him informed, to coordinate activities and to insure the timely implementation of specific activities.

FIGURE 8
RED CLAY PROJECT
ORGANIZATIONAL STRUCTURE
and
FLOW CHART


Minnesota
Wisconsin
Carlton County SWCD
Ashland County SWCD
Douglas County SWCD
Fiscal Agent
Bayfield County SWCD
Iron County SWCD
Executive Committee
Project Director
Project Specialist
Research Committee
Demonstration Committee
Information - Education Committee

IX. ANALYSIS AND EVALUATION METHODS

Introduction

Due to the complexity of the Red Clay Project, it is difficult to discuss, without repetition, the various analysis procedures and evaluation techniques as they apply to the five separate study areas and the numerous demonstration and research activities. At this point, it is sufficient to state that all field and laboratory analysis methods follow standard formats and, where applicable, are consistent with USEPA recommended guidelines.

It is important to discuss analysis and evaluation methods relating the various self-contained work elements to the Project's overall goals and objectives. While it is essential to have self-contained systems of analysis and evaluation in each of the Project's work areas, it is even more important from the standpoint of the entire Project to devise a system to analyze and evaluate the research and demonstration elements for separate activities in order to show interrelationships between them and with the Project goals. The end result of any such system, or set of systems, would be a complete evaluation of the Project, the development of systems which would be applicable to other projects and programs, the production of evaluation reports, publications and recommendations, and, ultimately, the attainment of the Project goals.

Methods of Analysis

As was mentioned in the introduction, research activities will be subject to standard analyses consistent with USEPA recommendations. The research activity is being contracted to competent institutions and individuals familiar with the standard research and analysis techniques. This standardization of techniques will insure data compatibility.

The efficacy of the demonstration activities in improving water quality will be analyzed by the USGS monitoring systems described in this plan. Their handling of all the monitoring will insure a standard system of data collection and storage for later retrieval.

The WBSWCD Project Specialist, as a Project staff member, will be responsible for working with other Project staff to analyze the numerous research and demonstration programs to relate them directly to the Project goals and objectives. This will be done through an ongoing process of program coordination and review. This type of analysis will be managerial and somewhat subjective, relying on the more objective analyses being performed in the various programs and study areas. The objectiveness of this type of analysis will be met by the reports and publications produced. These reports and publications will analyze and evaluate the programs and will contain recommendations for their potential use in erosion and sedimentation control programs to improve water quality.

The one overriding analysis to which all research and demonstration aspects of the Project will be subjected is a cost-effectiveness analysis. Through this type of an analysis, the measured results of the programs can be viewed in light of their costs. The result will be a meaningful analysis of control measures and research activities with indications as to their realistic applicability to other demonstration projects or long-term erosion and sedimentation control programs.

Methods of Evaluation

Evaluation of any program should be a continual process. This is necessary to assess current status, catch any mistakes or errors and make necessary changes in program direction and emphasis. The Red Clay Project has built into its operational structure a system of quarterly and annual review meetings as well as ad hoc meetings of the various operational committees. These will serve the dual purposes of periodically reviewing Project progress and providing the format for ongoing program evaluation.

In addition to the various review meetings, ongoing program evaluation will be accomplished by visual, photographic, research and other appropriate methods. Upland treatments in the demonstration program will be periodically evaluated visually, making use of the generally accepted Universal Soil Loss Equation method. Structural facilities in the demonstration program will be continually evaluated by visual and photographic documentation. Erosion rates within the treated areas will be compared to rates in the untreated areas. Where streambank protection and sediment traps are planned, complete land surveys will be run. A geometric comparison of existing, as-built and end-of-project conditions will be made. Sedimentation and erosion will be measured from time of construction to the end of the Project.

The Project staff, through its management system, will be responsible for all program evaluation. To assist with this, the WBSWCD Project Specialist has been hired to accomplish specific objectives regarding program evaluation. Through the processes of programs coordination, data review, supplemental academic research and technical documentation, all programs will be evaluated in terms of the Project goals. Programs will have to lend themselves to helping achieve the goals and objectives. That is, they must fit into the development of long-term, basin-wide control programs for SWCD's in a cost-effective manner, successfully demonstrate new or innovative techniques for controlling erosion and sedimentation to improve water quality, provide new data for erosion and sedimentation control on red clay soils, and/or be of value in disseminating information or educating specified audiences.

Periodic evaluations will be contained in interior publications, reports and documents. Final evaluations, of course, will be contained in the final Project report to USEPA as well as in recommendations to the sponsoring SWCD's.

TABLE 20
RED CLAY PROJECT BUDGET
GENERAL SUMMARY

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Administration	255042	66563	49923	70530	52897	75354	56514	42595	31945
Nemadji (Minn)	1284750	289435	217077	479670	359753	503395	377546	12250	9187
Nemadji (Wis)	776750	208510	156382	320745	240559	232645	174481	14850	11138
Fish Creek	378850	127315	95486	144913	108685	91772	68829	14850	11138
Oronto/Parker Ck	236250	50000	37500	81500	62125	96500	72375	8250	6188
Ashland	238000	152290	115880	75850	56260	5230	3105	4630	3180
Info-Educ Program	105500	31875	23907	52375	39282	13375	10032	7875	5907
Research	549763	194608	143590	168700	126753	153135	115323	33320	24831
TOTAL	3824905	1120596	839745	1394283	1046314	1171406	848205	138620	103514

TABLE 21
RED CLAY PROJECT BUDGET
ADMINISTRATION

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Director burden	64149 12829	16845 3369	12634 2527	17752 3550	13314 2662	19402 3880	14551 2910	10150 2030	7612 1522
Specialist burden	58150 11630	15000 3000	11250 2250	16200 3240	12150 2430	17500 3500	13125 2625	9450 1890	7088 1418
Secretary burden	19686 6475	5244 1725	3933 1294	5496 1808	4122 1356	5871 1931	4403 1448	3075 1011	2306 758
Travel	20900	5900	4425	5900	4425	5900	4425	3200	2400
Indirect Costs	24423	6300	4725	6804	5103	7350	5512	3969	2976
Direct Costs	7800	1680	1260	2280	1710	2520	1890	1320	990
Printing	9000	2000	1500	2000	1500	2000	1500	3000	2250
Legal Service	10000	3000	2250	3000	2250	3000	2250	1000	750
Computer Service	10000	2500	1875	2500	1875	2500	1875	2500	1875
TOTAL	255042	66563	49923	70530	52897	75354	56514	42595	31945

TABLE 22
RED CLAY PROJECT BUDGET
NEMADJI BASIN - MINNESOTA

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Land Management	6700	4690	3518	2010	1508				
Land Treatment	386800	84845	63634	174060	130545	127895	95921		
Grade Stabilization	780000	156000	117000	273000	204750	351000	263250		
Monitoring	111250	43900	32925	30600	22950	24500	18375	12250	9187
TOTAL	1284750	289435	217077	479670	359753	503395	377546	12250	9187

TABLE 23
RED CLAY PROJECT BUDGET
NEMADJI BASIN - WISCONSIN

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Land Management	9600	6720	5040	2880	2160				
Land Treatment	277700	55540	41655	124965	93724	97195	72896		
Roadside Treatment	123000	30750	23062	73800	55350	18450	13838		
Grade Stabilization	194000	38800	29100	67900	50925	87300	65475		
Soil Survey	43000	21500	16125	21500	16125				
Monitoring	129450	55200	41400	29700	22275	29700	22275	14850	11138
TOTAL	776750	208510	156382	320745	240559	232645	174481	14850	11138

TABLE 24
RED CLAY PROJECT BUDGET
FISH CREEK BASIN

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Land Management	9950	6965	5223	2985	2238				
Land Treatment	174750	33650	25238	79028	59272	62072	46554		
Channel Protection	10700	3000	2250	7700	5775				
Land Management Regulations	7000	5000	3750	2000	1500				
Soil Survey	47000	23500	17625	23500	17625				
Monitoring	129450	55200	41400	29700	22275	29700	22275	14850	11138
TOTAL	378850	127315	95486	144913	108685	91772	68829	14850	11138

TABLE 25
RED CLAY PROJECT BUDGET
ORONTO/PARKER CREEK BASIN

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Design & Specifications	35000	20000	15000	15000	11250				
Construction	120000			40000	30000	80000	60000		
Soil Survey	10000			10000	7500				
Monitoring	71250	30000	22500	16500	12375	16500	12375	8250	6188
TOTAL	236250	50000	37500	81500	62125	96500	72375	8250	6188

TABLE 26
RED CLAY PROJECT BUDGET
ASHLAND SHORELINE STUDY AREA

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Design & Specifications	18000	18000	13500						
Indian Cemetery Installation	30000	15000	11250	15000	11250				
Madigan Beach Installation	150000	100000	75000	50000	37500				
Monitoring	34100	19290	16130	10850	7510	2330	930	1630	930
Evaluation	5900					2900	2175	3000	2250
TOTAL	238000	152290	115880	75850	56260	5230	3105	4630	3180

TABLE 27
RED CLAY PROJECT BUDGET
INFORMATION & EDUCATION PROGRAM

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Film	60000	20000	15000	40000	30000				
Consultant Fees	5400	1350	1013	1350	1013	1350	1013	1350	1013
Travel & Subsistence	8100	2025	1519	2025	1519	2025	1519	2025	1519
Production Costs	32000	8500	6375	9000	6750	10000	7500	4500	3375
TOTAL	105500	31875	23907	52375	39282	13375	10032	7875	5907

TABLE 28
RED CLAY PROJECT BUDGET
VEGETATIONAL COVER ANALYSIS (Rudy Koch)*

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Personnel Costs	27036	13799	11692	13237	10894				
Travel	500	300	225	200	150				
Equipment	1040	940	490	100	75				
Miscellaneous	3875	1850	550	2025	725				
Indirect Costs (.34)	9192	4691	3143	4501	3125				
TOTAL	41643	21580	16100	20063	14969				

*Dollar figures reflected in research line item

TABLE 29
RED CLAY PROJECT BUDGET
ROLE OF PLANT ROOTS IN RED CLAY EROSION (Donald Davidson)*

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Personnel Costs	72957	19122	15241	23463	21120	24494	22078	5878	5262
Travel	650	200	150	200	150	200	150	50	38
Equipment	1250	550	412	300	225	300	225	100	75
Miscellaneous	6600	1850	500	1850	550	1850	550	1050	650
Indirect Costs (.34)	24806	6502	4682	7978	3181	8328	3254	1998	739
TOTAL	106263	28224	20985	33791	25226	35172	26257	9076	6764

*Dollar figures reflected in research line item

TABLE 30
RED CLAY PROJECT BUDGET
EFFECT OF VEGETATION COVER ON SOIL WATER CONTENT OF RED CLAY SOILS AND EROSION CONTROL (Rudy Koch)*

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Personnel Costs	84466	24997	22535	25446	23103	26873	24457	7150	6534
Travel	1100	300	225	350	263	350	263	100	75
Equipment	7750	5525	4144	1350	1012	750	523	125	94
Miscellaneous	7125	1800	300	2150	250	2150	250	1025	250
Indirect Costs	28718	8499	2166	8652	3405	9136	3615	2431	1112
TOTAL	129159	41121	29370	37948	28033	39259	29108	10831	8065

*Dollar figures reflected in research line item

TABLE 31
RED CLAY PROJECT BUDGET
EFFECTS OF EROSION CONTROL ON AQUATIC LIFE IN THE NEMADJI RIVER AND ITS TRIBUTARIES (William Swenson)*

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Personnel Costs	96435	27261	26219	29483	28323	30558	29325	9133	8517
Travel	1825	500	375	550	413	550	413	225	169
Equipment	8245	5245	3275	1900	1900	1100	1100		
Miscellaneous	9100	2550	150	2550	150	3050	150	950	250
Indirect Costs (.34)	32787	9268	3459	10024	2430	10390	3071	3105	1066
TOTAL	148392	44824	33478	44507	33216	45648	34059	13413	10002

*Dollar figures reflected in research line item

TABLE 32
RED CLAY PROJECT BUDGET
LITTLE BALSAM SLOPE STUDY (Joe Mengel, Bruce Brown)*

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Personnel Costs	7050	7050	3300						
Travel	559	559	459						
Equipment	140	140	140						
TOTAL	7749	7749	3899						

*Dollar figures reflected in research line item

TABLE 33
RED CLAY PROJECT BUDGET
GROUND WATER STUDY NEMADJI BASIN - MINNESOTA (USGS)*

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Investigation	30000	24900	18675	4100	3075				
Report & Tour	4500			1000	750	3500	2625		
TOTAL	34500	24900	18675	5100	3825	3500	2625		

*Dollar figures reflected in research line item

TABLE 34
RED CLAY PROJECT BUDGET
RAINFALL AND TEMPERATURE MONITORING (Donald Olson)*

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Personnel Costs	44167	13114	9374	14727	10486	16326	11736		
Travel	2724	908	908	908	908	908	908		
Equipment	15605	6985	6985	4310	4310	4310	4310		
Miscellaneous	6810	1280	1280	2765	2765	2765	2765		
Indirect Costs (.439)	13751	3923	2536	4581	3015	5247	3555		
TOTAL	83057	26210	21083	27291	21484	29556	23274		

*Dollar figures reflected in research line item

TABLE 35
RED CLAY PROJECT BUDGET
MONITORING BUDGET - WISCONSIN (USGS)#

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Construction (5 class "A")	60000	60000	45000						
Operation (5 class "A")	231000	66000	49500	66000	49500	66000	49500	33000	24750
Operation (1 class "A-B")	24500	7000	5250	7000	5250	7000	5250	3500	2625
Construction (3 class "B")	4500	4500	3375						
Operation (3 class "B")	34650	9900	7425	9900	7425	9900	7425	4950	3713
TOTAL	354650	147400	110550	82900	62175	82900	62175	41450	31088

#Dollar figures reflected in the study area budget

TABLE 36
RED CLAY PROJECT BUDGET
MONITORING BUDGET NEMADJI BASIN - MINNESOTA (USGS)#

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Construction (2 class "A")	24000	24000	18000						
Operation (2 class "A")	56000	12000	9000	20000	15000	16000	12000	8000	6000
Operation (1 water qual. station)	18200	3900	2925	6500	4875	5200	3900	2600	1950
Construction (1 class "B")	1500	1500	1125						
Operation (1 class "B")	11550	2500	1875	4100	3075	3300	2475	1650	1238
TOTAL	111250	43900	32925	30600	22950	24500	18375	12250	9188

#Dollar figures reflected in the study area budget

TABLE 37
RED CLAY PROJECT BUDGET
ASHLAND SHORELINE MONITORING AND EVALUATION PROGRAM (Tuncer Edil)#

	Item Total	FY 76 Elem.	FY 76 Grant Req.	FY 77 Elem.	FY 77 Grant Req.	FY 78 Elem.	FY 78 Grant Req.	FY 79 Elem.	FY 79 Grant Req.
Personnel Costs	18400	10470	8350	5980	3740	1210	270	740	270
Travel	3000	1200	1200	800	800	500	500	500	500
Equipment	1000	500	500	500	500				
Miscellaneous	2000	1500	1500	500	500				
Indirect Costs (.58)	9700	5620	4580	3070	1970	620	160	390	160
TOTAL	34100	19290	16130	10850	7510	2330	930	1630	930

#Dollar figures reflected in the study area budget

TABLE 38
RED CLAY PROJECT BUDGET
TECHNICAL ASSISTANCE (USDA - Soil Conservation Service)

	Unit Cost	Total	FY 76 Elem.	FY 77 Elem.	FY 78 Elem.	FY 79 Elem.
Soil Conservationist (4.6 m/yr.)	19804	91100	39609	25746	19804	5941
Wisconsin (4.0 m/yr.)		79216	33667	21784	17824	5941
Minnesota (.6 m/yr.)		11884	5942	3962	1980	
Soil Scientist (4.8 m/yr.)	21062	101100	42125	42125	16850	
Wisconsin (4.8 m/yr.)		101100	42125	42125	16850	
Engineer (5 m/yr.)	22400	112000	38080	33600	31360	8960
Wisconsin (1.2 m/yr.)		26880	13440	6720	6720	
Minnesota (3.8 m/yr.)		85120	24640	26880	24640	8960
Conservation Technician (3.7 m/yr.)	10000	37000	13000	14000	10000	
Wisconsin (3.3 m/yr.)		33000	11000	13000	9000	
Minnesota (.4 m/yr.)		4000	2000	1000	1000	
Engineering Technician (9.4 m/yr.)	10798	101500	32394	37792	31314	
Wisconsin (2.4 m/yr)		25915	7559	12957	5399	
Minnesota (7.0 m/yr)		75585	24835	24835	25915	
Support Specialists (4.5 m/yr.)	28889	130000	57778	37556	26000	
Wisconsin (2.0 m/yr.)		57778	26000	17333	11556	
Minnesota (2.5 m/yr.)		72222	31778	20223	14444	
TOTAL (32.0 m/yr.)	17897 (Av.)	572704	214764	196867	143176	17897
Wisconsin (17.7 m/yr.)		316777	125279	116330	68009	7159
Minnesota (14.3 m/yr.)		255927	89485	80537	75167	10738

APPENDIX A
DESCRIPTION OF SOIL ASSOCIATIONS
NEMADJI BASIN

The General Soils Map, page 16, shows the general pattern and distribution of soils. Each soil association is described below. Soils in associations 1, 2 and 8 developed in slack-water deposits. Soils in association 3 developed in glacial till. Soils in associations 4 and 5 developed in glacial outwash. Soils in association 7 developed in till and outwash. Soils in association 6 developed in organic material.

1. Campia - Spooner Association

   This association consists of nearly level to sloping, moderately well and well drained, and nearly level poorly and somewhat poorly drained soils formed in glacial lake-laid silt.

   The landscape consists of a nearly level silty glacial lake plain with gently sloping and sloping areas near drainageways and depressions.

   This soil association occupies about 4 percent of the watershed.

   Campia soils are moderately well and well drained. They are on broad lake plains and on gently sloping to sloping areas along drainageways. They have a surface layer of dark grayish brown silt loam and a subsoil that is dark yellowish brown silty clay loam.

   Spooner soils are level to depressional. They are somewhat poorly drained and are on concave slopes or in drainageways. They have a very dark gray silt loam surface layer and a subsoil that is mottled olive gray silt loam.

2. Ontonagon - Rudyard - Bergland Association

   This association consists of nearly level to moderately steep, well to poorly drained soils formed in reddish brown glacial lake-laid clay.

   The landscape consists of nearly level glacial lake plain with gently sloping to moderately steep areas near drainageways.

   This association occupies about 31 percent of the watershed.

   Ontonagon soils are nearly level to moderately steep. They are moderately well and well drained and are on plane or convex slopes. They have a surface layer of very dark gray silty clay and a subsoil of reddish brown clay.

Rudyard soils are level to depressional. They are somewhat poorly drained and are on concave areas or in drainageways. They have a surface layer of very dark brown silty clay loam and a reddish brown subsoil that is mottled in the upper part.

Bergland soils are depressional and are poorly drained. They have a black silty clay surface layer and a subsoil that is dark reddish gray in the upper part and reddish brown in the lower part.

3. Ahmeek - Ronneby - Washburn Association

This association consists of nearly level to steep well, to somewhat poorly drained soils with loamy subsoils.

The landscape consists of undulating and hilly glacial ground moraines with steep sided depressions. Surface stones are common.

This association occupies about 30 percent of the watershed.

Ahmeek soils are well and moderately well drained and occur on gently sloping to sloping ground moraines. They have very dark brown silt loam surface layer, a dark reddish brown subsurface layer and a subsoil of dark reddish brown, firm sandy loam.

Ronneby soils are somewhat poorly drained and occur on flat or slightly depressional ground moraines. They have a black loam surface layer. The upper part of the subsoil is dark brown mottled sandy loam and the lower part is reddish brown mottled, firm, sandy loam.

Washburn soils are well drained and occur on gently sloping to steep ground moraines. They have very dark gray sandy loam surface soil and a reddish gray sandy loam subsurface soil. The subsoil is reddish brown sandy loam in the upper part and yellowish red sandy loam in the lower part.

4. Omega - Cloquet Association

This association consists of nearly level to steep somewhat excessively drained sandy soils.

The landscape consists of pitted glacial outwash plains and the linear beach of Glacial Lake Duluth. It is nearly level to moderately steep with many depressions.

This soil association occupies about 15 percent of the watershed.

Omega soils are nearly level to moderately steep and are somewhat excessively drained. They have a surface layer of brown loamy sand and a subsoil of reddish brown loamy sand.

Cloquet soils are nearly level to steep and are somewhat excessively drained. They have a thin black sandy loam surface layer, a dark brown sandy loam subsurface layer and a subsoil of reddish brown sandy loam.

5. Nemadji - Newson Association

This association consists of nearly level, somewhat poorly and poorly drained sandy soils.

The landscape consists of a flat outwash plain with ground water at a depth of 0 to 3 feet. Shallow depressions are common.

This soil association occupies about 7 percent of the watershed.

The somewhat poorly drained Nemadji soils are nearly level or depressional. They have a thin, black, fine sand surface layer, a reddish gray, fine sand subsurface layer, and a reddish brown and yellowish red fine sand subsoil that is mottled.

The poorly drained Newson soils are in shallow depressions. They have a black mucky sand surface layer and a subsoil of grayish brown sand.

6. Greenwood - Loxley Association

This association consists of very poorly drained organic soils in broad depressions.

The landscape consists of nearly level organic soils in broad depressions within the till, outwash or lake plains.

This soil association occupies about 2 percent of the watershed.

Greenwood soils have very acid, dark reddish brown mucky peat surface soil and dark brown mucky peat subsoil.

Loxley soils have very acid, very dark brown muck surface soil and a black muck subsoil.

7. Ahmeek - Omega Association

This association consists of gently sloping, well drained sandy loam glacial till soils and somewhat excessively drained sandy outwash soils.

The landscape includes pitted glacial outwash plains, linear beach deposits, and undulating sandy loam ground moraine with steep sided depressions.

This association occupies about 2 percent of the watershed.

Ahmeek soils are well and moderately well drained on gently sloping to sloping ground moraine. They have a very dark brown silt loam surface layer, a dark reddish brown subsurface layer and a subsoil of dark reddish brown firm sandy loam.

Omega soils are gently sloping to sloping and are somewhat excessively drained. They have a surface layer of brown loamy sand and a subsoil of reddish brown loamy sand.

8. Steep Clayey Land

This association consists of steep, well drained clayey and silty glacial lake-laid sediments.

The landscape consists of the steep valley slopes of the Nemadji River and its tributaries.

This soil association occupies about 9 percent of the watershed.

The soils in this association are similar to the Ontonagon soils. Slips, slides and raw streambanks with exposures of silt and sand layers are common.

FISH CREEK BASIN

The General Soils Map of the Fish Creek Basin, page 50, shows the general pattern and distribution of soils. Each soil association is described below.

1. Ontonagon - Pickford Association

This association consists of nearly level to sloping, well to poorly drained clayey soils.

The landscape in this association consists of nearly level glacial lake basins that are gently sloping to steep near drainageways. The soils formed in lake-laid clayey sediments with few, thin silt and fine sand strata.

This soil association occupies about 63 percent of the watershed. About 55 percent is made up of Ontonagon soil, 35 percent Pickford soil and 15 percent minor soils.

Ontonagon soils are nearly level to sloping. They have a surface layer of reddish brown silty clay loam and a subsoil of slowly permeable reddish brown clay.

Pickford soils are nearly level and poorly drained. They have a surface layer of very dark brown silty clay loam and a subsoil that is mottled brown, reddish brown and gray clay.

Minor inclusions are the somewhat poorly drained Allendale and Rudyard, and well drained Bibon soils. Rudyard soils are clayey and are in slight depressions within Ontonagon soil areas. Allendale and Bibon soils formed in 40 to 60 inches of sandy over clay. They are at the margin of the glacial lake plain or in sandy beach ridges within the glacial lake plain.

2. Orienta - Superior Association

This association consists of nearly level and gently sloping, somewhat poorly and moderately well to well drained sandy outwash soils.

The landscape of this association consists of an undulating layer of outwash sand overlying clay on the margin of the lake plain and on beach ridges on the lake plain.

This association occupies about 13 percent of the watershed. About 48 percent of this association is made up of Orienta soil, 31 percent is made up of Superior soil and the remaining 21 percent minor soils.

Orienta soils are somewhat poorly drained and nearly level to gently sloping. They developed in 40 to 60 inches of sand over clay. The surface is dark brown and reddish gray sandy loam and loamy sand. The subsoil is mottled reddish brown sand over red clay.

Superior soils are moderately well and well drained and nearly level to gently sloping. They developed in less than 20 inches of loams over clay. The surface is very dark gray loam and sandy loam. The subsoil is red clay and silty clay.

Minor soils are the poorly drained Ogemaw and well drained Bibon soils. Ogemaw and Bibon soils have 20 to 40 inches of sand and loamy sand over clay. They are at the margins of the glacial lake plain or on sandy beach ridges within the glacial lake plain.

3. Vilas - Omega Association

This association consists of nearly level to steep, somewhat excessively drained sandy outwash soils.

The landscape of this association consists of pitted outwash bordering the glacial lake basin and linear beach ridges within the glacial lake basin.

This association occupies about 14 percent of the watershed. About 55 percent of this association is Vilas soil, 30 percent is Omega soil and 15 percent is minor soils.

Vilas soils are somewhat excessively drained and nearly level to steep. They have a surface layer of very dark gray and reddish gray loamy sand. The subsoil is reddish brown and brown loamy sand and sand.

Omega soils are excessively drained and gently sloping to steep. They have a surface layer of black and reddish gray sand. The subsoil is light reddish brown and brown sand.

Minor soils in this association are the poorly drained Kinross and somewhat excessively drained Bibon soils. Kinross soils are sandy and in depressions. The sandy Bibon soils are on gently sloping to sloping topography.

4. Gogebic - Cloquet Association

This association consists of gently sloping to steep, well drained stony, sandy and loamy glacial till soils.

The landscape of this association consists of undulating glacial till plains and rolling end moraines. The soils formed in stony sandy loam and loamy sand glacial till.

This association occupies about 5 percent of the watershed. About 76 percent of this association is made up of Gogebic soils, 15 percent is made up of Cloquet soils and the remaining 19 percent is minor soils.

Gogebic soils are gently sloping to steep and well drained. They have a surface layer of very dark brown and brown sandy loam or loam. The subsoil is reddish brown sandy loam.

Cloquet soils are gently sloping to steep and well drained. They have a very dark brown to reddish brown sandy loam or loamy sand surface horizon. The subsoil is reddish brown coarse loamy sand and sand.

The minor soils in this association are somewhat excessively drained sandy Washburn soils and poorly drained Adolph soils. Washburn soils are on ridges and Adolph soils are in depressions.

5. Steep Clayey Land Association

This association consists of steep sided, well drained ravines cut into clayey glacial lake basin sediments. The soil association occupies about 4 percent of the watershed. About 90 percent is Ontonagon soil and 10 percent minor soils.

The Ontonagon soils are described in Soil Association 1. The minor soils are described in Soil Associations 6 and 3.

6. Alluvial Land Association

These are nearly level, well to poorly drained soils formed in alluvial deposits along streams.

The landscape in this association consists of a nearly level flood plain along Fish Creek. The soils formed in a mixture of sand, loams and clay with some thin organic deposits.

This soil association occupies about 1 percent of the watershed.

APPENDIX B
LAND CAPABILITY UNITS

The soils of the Nemadji and Fish Creek Basins have been classified into capability groupings that indicate their general suitability for most kinds of farming. These are practical groupings based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

The units in this report are a combination of the groupings of soils of Minnesota and Wisconsin. They are intended for use in this report only. The land capability maps for Skunk Creek Basin, Minnesota; Little Balsam Creek Basin and Fish Creek Basin, Wisconsin are on pages 25, 38 & 53 respectively.

In this system all soils are grouped at three levels, the capability class, subclass and capability unit. The capability classes in the broadest grouping are designated by Roman numerals II through VIII. In class II are the soils that have the least limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and land forms so limited that they do not produce economically worthwhile yields of crops, forage or wood products.

The subclasses indicate major kinds of limitations within the classes. There are four subclasses within each class, each identified by a lower case letter. The letter "e" indicates that the main limitation on the use of the soil for cultivated crops is risk of erosion unless close-growing plant cover is maintained; "w" indicates wetness, that water in or on the soil will interfere with plant growth or cultivation; "s" indicates that the use of the soil for cultivated crops is limited mainly because it is shallow or drouthy.

Each subclass is further divided into capability units. These consist of groups of soils that are very similar and, therefore suited to the same kinds of crop and pasture plants, require similar management and have similar productivity and other responses to management. Capability units are identified by numerals added to the class and subclass code, for example IIIe2.

This classification system is based on the degree and kind of permanent limitations, without consideration of alterations that would change the characteristics of the soil.

IIe1

Included in this unit are deep, well drained loamy Baudette soils on nearly level lacustrine basins, and Duluth and

Gogebic soils on glacial till uplands. Gogebic soils have a weak fragipan in the subsoil. The soils in this unit have moderate to moderately slow permeability and have a medium available moisture and fertility-holding capacity.

The soils in this unit have a slight erosion hazard. Contour farming, diversions, sod waterways and proper crop rotation along with minimum tillage are among the measures that can be used to control erosion and slow runoff.

There is a slight erosion hazard on tree harvest areas and skid roads. There is a slight limitation on equipment use for tree planting, management and harvest. Seedling mortality is slight. Plant competition is slight for conifers and moderate for hardwoods.

The soils in this group are well suited for growing the grasses and legumes used for forage. Pasture and hayland management practices are easy to apply.

IIe2

This unit includes moderately deep, moderately well and well drained, clayey Ontonagon soils on gently sloping uplands.

These soils have a moderately slow permeability and medium available moisture and fertility-holding capacity. Water ponds for short periods in depressions. Tilth is difficult to maintain.

The soils in this unit have a slight erosion hazard. Diversions, minimum tillage, contour tillage and grassed waterways are needed to control erosion. Crop residue and minimum tillage will help increase the organic matter content, improve tilth and reduce erosion. Random surface drains and landsmoothing will eliminate wet spots.

There is a slight erosion hazard on tree harvest areas and skid roads. There is a slight limitation on equipment use for tree planting, management and harvest. Seedling mortality is moderate. The wind throw hazard is slight. Plant competition is slight for hardwoods and moderate for conifers.

These soils are well suited for growing grasses and legume crops that are used for forage. Surface drainage is needed to dispose of ponded water in low spots. Tillage practices should be applied when the soils are at proper moisture level to help maintain good tilth. Fall tillage helps to prepare a satisfactory seedbed for the spring.

IIe3

This unit includes well drained Superior soils formed in sand overlying clay at depths of 10 to 20 inches, and poorly drained sandy Ogemaw soils overlying clay at 40 to 60 inches. These soils are on gently sloping uplands and benches. Permeability is rapid in the sandy upper part and slow in the clayey lower part. These soils have medium available moisture and fertility-holding capacity. They are somewhat drouthy during extended dry periods.

The soils in this unit have a slight erosion hazard. Erosion is the main hazard. Diversions, contour tillage and grassed waterways are needed for erosion control. Crop residue and minimum tillage help to increase the organic matter content, maintain tilth, and control erosion. Wet seepage spots can be controlled with interception surface drains.

There is a slight erosion hazard on tree harvest areas and skid roads. There is a slight limitation on equipment use for tree planting, management and harvest. Seedling mortality is moderate. There is a slight wind throw hazard. Plant competition is slight for hardwoods and moderate for conifers.

These soils are well suited for growing the grasses and legumes used for forage. Some surface drainage is needed. Alfalfa generally out-yields other species.

IIs1

Moderately deep, moderately well and well drained, clayey Ontonagon soils on nearly level uplands. These are slowly permeable soils with medium available moisture and fertility-holding capacity. The surface generally has a microrelief of low swells and swales, and water ponds for short periods in the depressions.

Poor tilth and ponded surface water are the main hazards. Surface drainage is needed to remove wet spots. Crop residue management and minimum tillage increases the organic matter content and helps to maintain good tilth.

There is a slight erosion hazard on tree harvest areas and skid roads. There is a slight limitation on equipment use for tree planting, management and harvest. Seedling mortality is moderate following tree planting. There is a slight wind throw hazard. Plant competition is slight for hardwoods and moderate for conifers.

These soils are well suited for growing forage crops. Some surface drainage is needed. Fall tillage helps to obtain a satisfactory seedbed for the spring.

This unit is class III in Minnesota.

IIw1

This unit includes deep, somewhat poorly drained, loamy Tula soils on nearly level low areas in glacial till uplands. These soils have moderate permeability and medium available moisture and fertility-holding capacity. They have a seasonal high water table.

Wetness is the major hazard. Surface drainage and grassed waterways are needed. Diversions that intercept runoff from adjacent uplands are beneficial. Grassed or structural outlets are needed for diversions and surface drains. Minimum tillage and crop residue management help maintain good tilth.

Erosion hazard on tree harvest areas and skid roads is slight. There is a slight limitation on equipment use for tree planting, management and harvest. Seedling mortality and wind throw hazard is slight. Plant competition is moderate for hardwoods and severe for conifers.

These soils are suited for growing many of the grasses and legumes used for forage. Management practices and the choice of plant species are limited somewhat by wetness. Where adequate drainage can be provided, and applications of lime and fertilizer are made, alfalfa stands can be established and maintained. Red clover should be considered where drainage is not adequate.

IIw2

Included in this unit are moderately deep, somewhat poorly drained silty Spooner soils on nearly level lacustrine basins. These soils have moderate permeability and high available moisture and fertility-holding capacity. They have a seasonal high water table and surface water ponds in depressions for short periods.

Wetness is the main limitation. Surface drainage, conservation cropping systems, crop residue management and minimum tillage are needed practices.

The erosion hazard on tree harvest areas and skid roads is slight. There is a slight limitation on equipment use for tree planting, management and harvest. There is a slight limitation on equipment use for tree planting, management and harvest. There is a slight seedling mortality hazard. Wind throw hazard is slight. Plant competition is moderate for hardwoods and severe for conifers.

These soils are suited for growing many of the grasses and legumes used for forage crops. Management practices and the choice of plants are limited due to wetness. Where adequate drainage can be provided and applications of lime and fertilizer are made, alfalfa stands can be established and maintained. Without adequate drainage, red clover should be considered.

IIIe1

This unit includes deep, well drained loamy Baudette soils on sloping lacustrine basins, and moderately deep well drained Duluth and Gogebic soils on sloping glacial till uplands. Permeability is moderate to moderately slow. They have a medium available moisture and fertility-holding capacity. Gogebic soils have a fragipan in the subsoil.

The soils in this unit have a moderate erosion hazard. Contouring is the control practice most applicable on slopes. Grassed waterways are needed to control erosion in drainageways.

The erosion hazard is slight on tree harvest areas and skid roads. There is a slight limitation for equipment use for tree planting, management and tree harvest. There is moderate limitations for seedling mortality and wind throw. Plant competition is moderate for hardwoods and severe for conifers.

These soils are well suited for growing the grasses and legumes used for forage. Pasture and hayland management practices are easy to apply.

This unit is class IV in Minnesota.

IIIe2

This unit includes moderately deep, well drained, clayey Ontonagon soils on sloping uplands. These soils have slow permeability and medium available moisture and fertility-holding capacity.

The soils in this unit have a moderate erosion hazard. Diversions, contour tillage, grassed waterways, crop residue management and minimum tillage are among the measures needed for control of erosion.

There is a slight erosion hazard on tree harvest areas and skid roads. There is a slight limitation on equipment use for tree planting, management and harvest. There is a slight wind throw and seedling mortality hazard. Plant competition is slight for hardwoods, moderate for conifers.

These soils are well suited for growing the grasses and legumes used for forage. Some surface drainage is needed. Tillage practices should be applied when the soils are at the proper moisture level. Fall tillage helps to obtain a satisfactory seedbed for the spring.

IIIe3

This unit includes deep, well to excessively drained Cloquet, Marenisco and Washburn soils on gently sloping uplands. These soils have moderate to moderately rapid permeability and moderately low available moisture and fertility-holding capacity. They are drouthy and are subject to both a water and wind erosion hazard.

The soils in this unit have a slight erosion hazard. Contour tillage and proper cropping system help to control erosion. Minimum tillage and crop residue management improve tilth and increase the organic matter and water-holding capacity.

These soils have a slight erosion hazard on tree harvest areas and skid roads. There is a slight limitation for equipment use for tree planting, management and harvest. There is a moderate seedling mortality and wind throw hazard. Plant competition for hardwoods is slight and conifers is moderate.

The soils are well suited for growing many of the grasses and legumes used for forage. Alfalfa generally outyields other species.

IIIw1

Included in this unit are moderately deep somewhat poorly and poorly drained clayey Rudyard, Bergland and Pickford soils on nearly level lake plains. These soils are slowly permeable, have moderately high available moisture and moderate fertility-holding capacity. They are subject to water ponding on the surface and have a climatic limitation.

Wetness is the main hazard. Maintaining good tilth is a serious problem. Surface drainage and land smoothing is needed. Crop residue management and minimum tillage are needed for these soils.

These soils have a slight erosion hazard on tree harvest areas and skid roads. There is a severe limitation on Bergland and Pickford soils for equipment use in tree planting, management and harvest, seedling mortality and plant competition. On Rudyard soils the limitation is moderate. There is a severe wind throw hazard.

With adequate drainage, these soils are suited for growing many of the grasses and legumes used for forage. Without drainage, ponded surface water restricts the use of many species. When drained, these soils are suited for alfalfa production.

This unit is class IV in Minnesota.

IIIw2

Included in this unit are somewhat poorly drained silty Dusler soils on nearly level uplands. These soils have slow permeability and high available moisture and fertility-holding capacity.

Wetness is the main limitation. Maintaining good tilth is a problem. Surface drainage and crop residue management is needed.

Erosion hazard on tree harvest and skid roads is slight. Limitations on equipment use during tree planting, management and harvest is moderate. There is a moderate seedling mortality following tree planting. Wind throw hazard is slight. Plant competition is moderate for hardwoods and severe for conifers after harvest.

The soils in this group are suited for growing many of the grasses and legumes used for forage. Management practices and some plant species are limited due to wetness. Where adequate surface drainage can be provided and applications of lime and fertilizer are made, alfalfa stands can be established and maintained. Without adequate drainage and a high fertility level, red clover should be considered.

IIIw3

This unit includes moderately deep, somewhat poorly drained sandy Allendale soils and deep poorly drained Ogemaw soils. These soils are underlain by clay at depths of less than 60 inches. They are on gently sloping uplands and benches. These soils have rapid permeability and medium to low available moisture and fertility-holding capacity in the upper sandy layer. There is a seasonal high water table.

Wetness is the main limitation. Surface drainage or tile laid in the clayey substratum material is needed for best crop production.

Wetness is the main limitation. Surface drainage or tile laid in the clayey substratum material is needed for best crop production.

The erosion hazard is slight on tree harvest areas and skid roads. There is a slight limitation on equipment for use for tree planting, management and harvest. Seedling mortality and wind throw hazard is slight. Plant competition is slight for hardwoods and moderate for conifers.

These soils are unsuited for growing many forage species due to seasonal high water table followed by drouthiness as the water table is lowered during the growing season. When adequately drained, red clover should be considered. Without adequate drainage, bluegrass should be grown.

IVe1

Moderately deep, well drained, loamy Gogebic soils on moderately steep glacial till uplands. These soils have a fragipan in the subsoil. They are moderately permeable and have a medium available moisture and fertility-holding capacity.

These soils have a severe erosion hazard. Permanent grassed waterways, contour cultivation, crop residue management and minimum tillage control runoff and erosion.

Erosion hazard on tree harvest areas and skid roads is moderate. There is a moderate limitation on equipment use for tree planting, management and harvest. There is a moderate seedling mortality and wind throw hazard. There is moderate plant competition for hardwoods and severe plant competition for conifers after harvest.

These soils are well suited for growing forage crops. Alfalfa generally outyields other species.

IVe2

This unit includes moderately deep, well drained, clayey Ontonagon soils on moderately steep uplands. These soils have a slow permeability and a medium available moisture and fertility-holding capacity. Water ponds for short periods in depressions.

These soils have a severe erosion hazard. Contour cultivation, diversions and grassed waterways help control runoff and erosion. Crop residue management and minimum tillage improve tilth and reduce runoff.

There is a moderate erosion hazard on tree harvest areas and skid roads. There is a severe limitation on equipment use for tree planting, management and harvest. There is a moderate seedling mortality hazard on north and east facing slopes. On south and west facing slopes the seedling mortality is severe. There is a slight wind throw hazard. Plant competition is severe for hardwoods and moderate for conifers.

These soils are suited for growing the grasses and legumes used for forage. Tillage practices should be applied when the soils are at the proper moisture level. Alfalfa generally outyields other species.

This unit is class VII in Minnesota.

IVe3

This unit includes moderately deep and deep, well to excessively drained sandy Marenisco and Washburn soils on sloping uplands. These soils have moderately rapid permeability and moderately low available moisture and fertility-holding capacity.

These soils have a moderate erosion hazard and they are somewhat drouthy. Contour cultivation, grassed waterways, crop residue management and minimum tillage improve tilth and reduce erosion.

The erosion hazard is slight on tree harvest areas and skid roads. There is a slight limitation on equipment use for tree planting, management and harvest. The seedling mortality hazard is slight. There is a slight wind throw hazard. Plant competition is slight for hardwoods and moderate for conifers.

These soils are drouthy and suited for growing only a limited number of species for forage. Forage yields are generally low.

IVs1

This unit includes deep excessively drained sandy Omega and Vilas soils on nearly level to sloping uplands. Also included are deep excessively drained sandy Bibon soils and somewhat poorly drained Orienta soils with clayey layers at depths of less than 60 inches.

Permeability is rapid in the sandy material, slow in the clay. Available moisture capacity and fertility-holding capacity is low in the sands.

These soils are drouthy and have a moderate erosion hazard on slopes. They are subject to wind and water erosion. Crop residue management, minimum tillage and cover crops help to control erosion and improve soil moisture-holding capacity.

These soils have a slight erosion hazard on tree harvest areas and skid roads areas. There is a slight limitation on equipment use for tree planting, management and harvest. There is a moderate seedling mortality hazard. Wind throw hazard is slight. Plant competition is slight for hardwoods and moderate for conifers.

These soils are suited for growing only a limited number of species for forage. Alfalfa generally outyields all other species.

IVw1

Included in this unit are deep, poorly drained Rifle soils in depressional areas. These organic soils have a high water table, moderately rapid permeability, and high available moisture and fertility-holding capacity.

Soil wetness and severe frost hazard are the main limitations. Water ponds on the surface during wet seasons. Surface drainage is needed for general crop production. Wind erosion and subsidence are hazards when these soils are drained and cultivated.

Erosion hazard is slight on tree harvest areas and skid roads. Because of the low bearing value of these soils, there is a severe limitation on equipment use for tree planting, management and harvest. Seedling mortality, wind throw hazard and plant competition is severe.

Due to excess water, generally low fertility and some water ponding on the surface these soils are unsuited for growing many forage species. The low bearing value limits the use of these soils for livestock grazing. Without adequate drainage, reed canary grass is the only adapted species. When adequately drained red clover and reed canary grass are the species to plant.

IVw2

Included in this unit are deep, poorly drained sandy Kinross and Newson soils on nearly level and depressional topography. These soils are rapidly permeable, and have a low available moisture and fertility-holding capacity. Ground water is at or near the surface seasonally.

Wetness is the main hazard. Surface drainage is needed for crop production. When drained and cultivated they have a severe wind erosion hazard. Crop residue management, minimum tillage and cover crops help to maintain good tilth and reduce wind erosion.

These soils have a slight erosion hazard on tree harvest areas and skid roads. There is a severe limitation on equipment use for tree planting, management and harvest. There is moderate seedling mortality hazard and wind throw hazard. Plant competition is moderate.

Because of the high water table, these soils are unsuited for growing many forage species. When adequately drained, red clover should be considered. Without adequate drainage, this soil should be managed for bluegrass.

IVw3

Included in this unit are moderately deep, somewhat poorly drained, sandy Nemadji and Orienta soils on nearly level outwash and lake plains. These soils have a seasonal high water table, are rapidly permeable and have a low available moisture and fertility-holding capacity. Orienta soils are underlaid with clay at less than 60 inches.

Wetness is the limiting management hazard. Surface drains are needed for best crop production. When drained and cultivated there is the possibility of wind erosion.

There is a slight erosion hazard on tree harvest areas and skid roads. There is a slight limitation on equipment use for tree planting, management and harvest. There are moderate seedling mortality hazards following tree planting. There is a slight wind throw hazard. Plant competition is slight for hardwoods and conifers.

These soils are unsuited for growing many forage species due to the seasonal high water table. When adequately drained, red clover should be considered. Without adequate drainage, these soils should be managed for bluegrass.

IVw4

This unit includes deep, poorly drained loamy Mahtowa and Blackhoof soils on nearly level uplands and in depressional areas. These soils have slow permeability and moderately high available moisture and moderately low fertility-holding capacity. The water table is within one foot of the surface during most of the growing season.

Wetness is the main limitation. Surface drainage and land smoothing are needed for best cropland production. Minimum tillage helps maintain organic matter content and promotes good tilth.

These soils have a slight erosion hazard on tree harvest areas and skid roads. There is a severe limitation on equipment use for tree planting management and harvest. There is a severe seedling mortality. There is a severe wind throw hazard. Plant competition is severe.

When drained these soils are suited for growing many of the grasses and legumes used for forage production. Unless drained, these soils have a high water table that restricts their use to species such as reed canary grass. With adequate surface drainage, red clover should be considered.

Vw1

This unit includes deep, poorly drained, loamy alluvial soils on nearly level stream flood plains. These soils have moderate permeability, high available moisture and moderate fertility-holding capacity. They have a high water table during wet seasons and are subject to frequent stream overflow.

Periodic flooding and soil wetness are the main limitations. Most areas of this soil are not used for cultivated crops.

The erosion hazard is slight on tree harvest areas and skid roads. There is a moderate limitation on equipment use for tree planting, management and harvest. There is a slight seedling mortality and wind throw hazard. Plant competition is slight for hardwoods and moderate for conifers.

Due to the periodic excess water and flooding hazard and the difficulty of providing protection from overflow, the soils in this group are unsuited for growing most of the grasses and legumes used for forage. With good management moderate yields of bluegrass may be expected.

VIe1

Included in this unit are moderately deep, well to excessively drained sandy Washburn and Marenisco soils on moderately steep uplands. These soils have moderately rapid permeability and moderately low available moisture and fertility-holding capacity.

These soils have a severe erosion hazard. A vegetated cover and protection from overgrazing help to control erosion.

The erosion hazard on tree harvest areas and skid roads is moderate. There is a moderate limitation on equipment use for tree planting, management and harvest. Seedling mortality hazard is slight on north and east facing slopes and moderate on south and west facing slopes. There is a slight wind throw hazard. Plant competition is slight for hardwoods and moderate for conifers.

These soils are drouthy and unsuited for growing many species for forage. Steep slopes and surface stones restrict the use of tillage implements in some areas. Where renovation is not feasible lime and fertilizer can be applied, brush removed and grazing controlled. Bluegrass should be grown where soils are not renovated.

VIs1

This unit includes deep excessively drained sandy Vilas soils on sloping uplands. These soils have rapid permeability and a very low available moisture and fertility-holding capacity.

Drouthiness and a severe erosion hazard are the main limitations. These soils are subject to wind erosion and water erosion when cultivated. A vegetated cover and protection from overgrazing help to control erosion.

The erosion hazard on tree harvest areas and skid roads is slight. There are slight limitations on equipment use for tree planting, management and harvest. There is a moderate seedling mortality hazard. There is a slight wind throw hazard. Plant competition limitations are slight for hardwoods and moderate for conifers.

These soils are drouthy and unsuited for growing many species for forage. Where renovation is possible, alfalfa generally outyields other species. Bluegrass should be grown where soils are not renovated.

VIIe1

This unit includes the steep slopes of deeply cut drainageways in the clayey Nemadji and Fish Creek Basins. These areas have a slow permeability and a medium available moisture and fertility-holding capacity. Runoff is very rapid and there is a severe erosion hazard. The slopes are unstable and are subject to massive slumping and soil slippage.

The erosion on tree harvest areas and skid roads is severe. There is a severe limitation on equipment use for tree planting, management and harvest. Seedling mortality hazard is moderate on north and east slopes, severe on south and west slopes. Plant competition is severe.

Most of these areas are in woodland. They are best suited to this use.

This unit is class VIII in Minnesota.

VIIw1

This unit includes deep, poorly drained, Greenwood and Bain soils and the moderately deep Beseman and Dawson soils on nearly level depressions. These fibrous organic soils have moderately rapid permeability, medium available moisture and low fertility-holding capacity, and are very acid in reaction. Water table is at or near the surface most of the year. Beseman and Dawson soils are underlaid by loam and sand respectively at 16 to 50 inches.

Low natural fertility, acidity, severe frost hazard, and wetness are the main hazards. Most areas of these soils are maintained in existing or natural vegetation.

The erosion hazard on tree harvest areas and skid roads is slight. The low bearing capacity of these soils puts a severe limitation on the use of equipment for tree management and harvest. There is a severe plant competition, seedling mortality and wind throw hazard.

Native vegetation on these soils is a forest cover of black spruce and tamarack trees with an understory of leatherleaf, laborador tea and sphagum moss. Growth is generally slow. The best use of these areas is to maintain them in their natural state.

This unit is class IV in Minnesota.

VIIIw1

This unit includes deep, poorly drained organic and mineral marshes in nearly level depressional areas bordering on lakes and streams. Water exists at or above the surface most of the year, and they are not suited for drainage. Vegetation is generally cattails, bulrushes and other aquatic species.

These areas are not suited for cropland or trees. They are better suited for wildlife habitat or recreation.

APPENDIX C
DEFINITIONS OF LAND TREATMENT PRACTICES

1. ACCESS ROAD is constructed as part of a conservation plan to provide needed access to other conservation measures. The estimated cost includes: clearing, earthwork, gravel surfacing and seeding.

2. AGRICULTURAL WASTE MANAGEMENT SYSTEMS is a planned system to contain and manage liquid and solid livestock wastes with disposal in a manner which does not degrade air, soil or water resources. The cost is an average typical cost of those recently constructed.

3. BRUSH MANAGEMENT is management of brush stands to restore plant communities and specific needs of the land users. The cost includes both chemical and mechanical brush control.

4. CONSERVATION CROPPING SYSTEM is growing crops in combination with needed cultural and management measures. Cropping systems include rotations that contain grasses and legumes as well as rotations in which the desired benefits are achieved without the use of such crops. The cost includes the land user's cost of establishing and maintaining contour strips, rotations, etc.

5. CRITICAL AREA PLANTING is stabilizing sediment-producing and severly eroded areas by establishing vegetative cover. This includes woody plants, such as trees, shrubs or vines, and adapted grasses or legumes established by seeding or sodding to provide long-term ground cover, (does not include tree planting mainly for the production of wood products). The acreage of this item does not include roadside seeding needed and seeding as part of other conservation measures.

6. CROP RESIDUE MANAGEMENT is using plant residues to protect cultivated fields during critical erosion periods. The cost is indicative of the added expense in converting to mulch tillage practices.

7. DIVERSION is a channel with a supporting ridge on the lower side constructed across the slope for the purpose of diverting water to areas where it can be disposed of safely. The cost includes earthwork and seeding.

8. DRAINAGE FIELD DITCH is a graded ditch for collecting excess water within a field. It does not include Grassed Waterway or Outlet. The quantity of this item is intended for application on the cropland.

9. FARMSTEAD AND FEEDLOT WINDBREAK is a belt of trees or shrubs established next to a farmstead or feedlot. The cost is for tree planting and materials.

0. FENCING is enclosing or dividing an area of land with a permanent structure that acts as a barrier to livestock or people. The quantity shown in the table is that needed for livestock exclusion from gullies and steep slopes. The cost is for material and labor.

11. FIELD WINDBREAK is a strip or belt of trees or shrubs established to reduce wind erosion on open fields. The cost is for tree planting and materials.

12. FLOODWATER RETARDING STRUCTURE is a single purpose structure providing for temporary storage of floodwater and for its controlled release. This structure is designed to trap sediment also, though not considered a purpose. The cost is the estimated construction cost for sites indicated on the work map.

13. GRADE STABILIZATION STRUCTURE is built to stabilize the grade or to control head cutting in natural or artificial channels. (Does not include stream channel improvement, streambank protection, diversions or structures for water control). The higher cost is representative for construction of a low head, crib type structures located in the stream channel to control gradient. The lower cost is representative for construction of high head, pipe drop type structures for small watersheds.

14. GRASSED WATERWAY is a natural or constructed waterway or outlet, shaped and graded, with vegetation established to safely dispose of runoff from a field, diversion, terrace or other structure. The cost includes earthwork and seeding.

15. LAND ADEQUATELY TREATED is using land within its capability on which the conservation practices that are essential to its protection and planned improvement have been applied.

16. LAND SMOOTHING is removing irregularities on cropland surfaces by use of special equipment.

17. LIVESTOCK EXCLUSION refers to areas where grazing is not wanted. The cost for doing such is the amount shown for fencing.

18. PASTURE AND HAYLAND MANAGEMENT is proper treatment and use of pastureland or hayland. The cost includes mowing and fertilization.

19. PASTURE AND HAYLAND PLANTING is establishing long-term stands of adapted species of perennial, biennial, or reseeding forage plants. (Includes pasture and hayland renovation, does not include grassed waterway or outlet on cropland).

20. RECREATION AREA IMPROVEMENT is establishing grasses, legumes, shrubs, trees or other plants or selectively reducing stand density to improve an area for recreation. The construction cost is included in other practices.

21. STOCK TRAILS, WALKWAY OR WATERING FACILITY a trail, walkway or watering facility provided to improve access to water for livestock when fencing is used to exclude livestock from prior watering areas.

22. STREAM CHANNEL PROTECTION AND SLOPE STABILIZATION includes all those structural measures design to control or reduce the amount of streambank erosion and stream side slope failure (clay slides).

23. STRIPCROPPING is the growing of crops in a systematic arrangement of strips or bands on the contour to reduce erosion. The cost includes the land user's cost of establishing and maintaining strips.

24. SUBSURFACE DRAINAGE is a conduit installed beneath the ground surface which collects and/or conveys drainage water. The cost includes installation and material.

25. TREE PLANTING is the planting of tree seedlings or cuttings. Costs include materials and planting.

26. WOODLAND IMPROVEMENT is removing unmerchantable or unwanted trees, shrubs or vines.

27. WOODLAND SITE PREPARATION is treating areas to encourage natural seeding of desirable trees or to permit reforestation by planting or direct seeding.

APPENDIX D
WATER QUALITY MONITORING

1. Description of class "A" monitoring station.

   a. A permanent shelter--heated, insulated and equipped with electricity.

   b. Continuous streamflow recorder.

   c. Automatic suspended sediment sampler to collect daily and storm event samples.

   d. Manual collection of suspended and bed material on an event basis by USGS.

   e. Intensive chemical quality monitoring.

2. Description of class "B" monitoring station.

   a. A semipermanent bridge-mounted installation.

   b. Peak flow recorder, crest-stage installation and wire-weight gauge to measure stage at time of sampling.

   c. Weekly and storm event suspended-sediment samples taken by local observer.

   d. Particle-size analysis samples collected on an event basis by USGS.

3. Parameters to be measured at all class "A" stations at the frequency shown.

Parameter	Frequency
temperature	continuous
specific conductance	"
discharge	"
"	instantaneous
pH	monthly
coliform, fecal MF, M-Fc	"
streptococci, fecal MF, M-entero	"
bicarbonate	"
carbonate	"
hardness, as $CaCO_3$	"
hardness, non-carbonate	"
calcium, dissolved	"
magnesium, dissolved	"
fluoride, dissolved	"
sodium, dissolved	"

Parameter	Frequency
potassium, dissolved	"
residue on evaporation	"
dissolved solids	"
silica, dissolved	"
turbidity, JTU	"
chloride	"
sulfate, dissolved	"
phosphorus, total as P	"
nitrite plus nitrate, total as N	"
nitrogen, total Kjeldahl as N	"
arsenic, dissolved	quarterly
arsenic, total	"
cadmium, dissolved	"
cadmium, total	"
chromium, dissolved	"
chromium, total	"
cobalt, dissolved	"
cobalt, total	"
copper, dissolved	"
copper, total	"
iron, dissolved	"
Iron, total	"
lead, dissolved	"
lead, total	"
manganese, dissolved	"
manganese, total	"
mercury, dissolved	"
mercury, total	"
selenium, dissolved	"
selenium, total	"
zinc, dissolved	"
zinc, total	"
total organic carbon	"
OTHER	
insecticides	one time (repeat if necessary)
herbicides	"
organochlorine compounds	"